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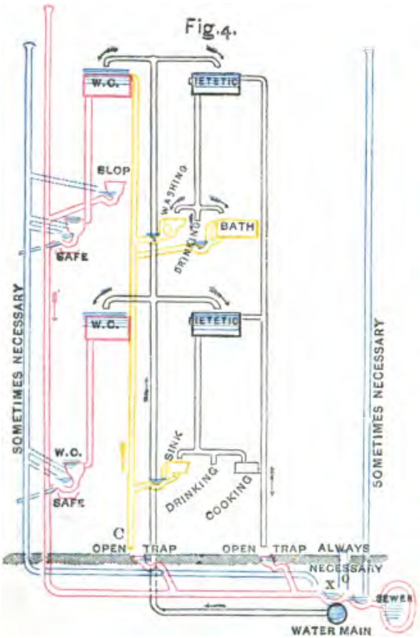
Fig.4.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HEALTHY HOUSES

BY

FLEEMING JENKIN, F.R.S.

PROFESSOR OF ENGINEERING IN THE UNIVERSITY OF EDINBURGH

ADAPTED TO AMERICAN CONDITIONS

BY

GEORGE E. WARING, JR.

WITH SIX ILLUSTRATIVE DIAGRAMS

NEW YORK

HARPER & BROTHERS, PUBLISHERS

FRANKLIN SQUARE

1879

NOTE BY THE AMERICAN EDITOR.

THIS sanitary fragment, by Professor Fleeming Jenkin, aside from its intrinsic merit as a most lucid exposition of the cardinal principles of House Drainage and Ventilation, derives especial interest from the fact that it was these lectures which led to the organization of the Sanitary Protection Association of Edinburgh—an Association which is evidently to be imitated in all parts of the world where the importance of "Healthy Houses" is appreciated.

A similar organization is in operation in Newport, and others are contemplated in the country. They are sure to increase as their advantages become known. They can be made known in no way more effectively than by the republication of the admirable

papers in which the necessity was first set forth, and the working of the system first explained.

Sufficient notes are added to make the lectures fully understood by American readers, and to bring the instructions into conformity with American practice.

GEORGE E. WARING, JR.

NEWPORT, R. I., *March*, 1879.

PREFACE.

THE three lectures now published were delivered in Edinburgh early in the present year. Two of these were addressed to the members of the Philosophical Institution, and the third to the Medico-Chirurgical Society. The lectures were spoken, not read, and the present version omits reference to several experiments which were employed to explain the principles laid down, but which would not, in a mere description, make the statements more intelligible. The Sanitary Protection Association is now established and in full work, whereas in the actual lectures my idea was publicly described for the first time, and was, of course, suggested with the hope, now happily realized, that the conception should be put to a practical test.

The third lecture, addressed to the Medico-Chirurgical Society, has already been printed by them. It explains, in greater detail, the mode in which the Association is being worked. It is hoped that the reader will excuse a few repetitions which will be met with in the text, and which arose from the fact that the lectures were delivered to different audiences.

The reader is also warned that these lectures are not intended to present a complete treatise on any branch of Sanitation, but merely to explain, in a popular way, a few leading principles, and to describe the object and working of the Sanitary Protection Association.

FLEEMING JENKIN.

Lecture I.

HEALTHY HOUSES.

HEALTHY houses!—Each year brings a crop of pamphlets, patents, reports, and letters on the subject; but year after year old houses remain much as they were, and new houses are built with new as well as old defects. Still, some progress is being made. Many engineers, architects, and medical men are now competent to give sound advice. Towns are one by one making better regulations as to building, and science pronounces more and more distinctly what the conditions of health are, and how they may be secured.

The tardiness which the public shows in applying these sound principles is by some attributed to apathy, and by others to ignorance. We find some writers, like Mr. Pridgin Teale, of Leeds, doing their best to stir us to action by stories of death and disease due to neglect of the simplest precautions; and, indeed, writers of this class need never

be gravelled for lack of matter. Others, such as Mr. Eassie, write sanitary primers to instruct the ignorant public, believing that many people would, if they knew how, willingly make their houses healthy. The authors of these tracts are doing useful work. Still, with the best will in the world, we cannot always be thinking about drains, nor can every householder qualify himself for the functions of house-surveyor and medical officer of health; so the practice of the father of a family usually is to let things alone until, under the alarm of an epidemic or of illness in his house, he decides that the drains must be looked into, and thereupon sends for a skilled or unskilled adviser, usually some local tradesman. Now, the local tradesman is not always competent to give sound advice. He is even sometimes very ignorant, and his workmen are sometimes careless, so that, after calling in the plumber, a man may always feel certain that he will have a considerable bill to pay, but can never feel certain that he has got his money's worth in safety.

Matters are somewhat mended when a sanitary engineer of repute is consulted, but the bill will be much larger. This gentleman feels bound to make the arrangements in

the house quite perfect, so every old water-closet comes out to make way for the newest patent; every crooked pipe and drain is made straight; sheaves of ventilating pipes from drains shoot up on all sides; baths, wash-hand basins, cisterns, must all be displaced, and replaced somewhere else in new forms and new materials. Holes are knocked in the walls and floors are taken up for shafts, openings, and pipes admitting air to the rooms. Hot-water pipes meander round the hall, and a furnace is built for them in the cellar. Old-fashioned grates are removed, and patent devices, puffing hot air into the room, appear in their stead. Man-holes, gratings, traps, louvers, cowls, extractors, influx-valves, efflux-valves, all patented, multiply beyond count; and the process of putting all the old things out and the new things in so guts the house that joiners, plasterers, and paperers have a good time. When all is done, the householder may think himself happy if, on his return, he does not find the arrangements such as to make him sigh for his old-fashioned, comfortable danger.*

* This alarming account of the practices of sanitary engineers is certainly not true with reference to this country, where the profession is by no means to be

Handing a good-sized family mansion over to a modern sanitary engineer not unfrequently means spending a couple of thousand pounds, and a man will subject himself and other people to considerable risk rather than spend two thousand pounds. Of course the writer does not mean to say that all local tradesmen are incompetent, or that all sanitary engineers make extravagant recommendations. On the contrary, both classes of men have done and do good service; but distrust of them is wide-spread, and is not wholly unjustifiable. This distrust is increased by the fact that so many of our advisers are patentees. Sanitary appliances are all patented, and the most clamorous of our would-be leaders have but one cuckoo cry—"Come buy, come buy." When woes are remediless, it is best to say nothing about them; and the writer, unless he had a cure to suggest, would never have enlarged on the disease. What has now been said is simply meant to show that conservatism in drains has a certain, not justification, but excuse.

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charged with the ludicrous performances whose enumeration has so run away with our author's imagination. It is also not true with reference to the best reputed sanitary engineers of England. It is probably not true of Prof. Jenkin himself.—*Am. ed.*

If you know that you will have to spend much money, and feel very uncertain as to the worth of what you will get, you are to be *excused* if you stop as you were; you are not *justified*, because, no doubt, it is your duty to make yourself so thoroughly conversant with this important subject as to be able at least to select competent advisers, and see that their advice is properly carried out. This is our duty; but it is to be feared we shall not do it without some pressure or assistance from others.

Let us consider very briefly what are the conditions of health in a house. They all depend on cleanliness, pure air, clean water, rapid removal of all refuse, perfect exclusion of all foul matters arising outside the house. But all dirt is not equally dangerous; some dirt is simply dirty, and thereby injurious to some extent; other dirt contains the germs of disease, and is not so much injurious as poisonous. Nothing perfectly clean can contain a germ of disease, and although this perfect cleanliness is an unattainable ideal, still it is an ideal after which we must strive. Our chief efforts must however be directed against those forms of dirt which are found by experience to contain disease-germs most frequently, and to prop-

agate them most freely. We may assume that disease-germs do not arise spontaneously. The assumption will lead to no conclusion which is dangerous, and explains much that would otherwise be obscure; as, for instance, how a Suffolk farmer will enjoy fair health, though he drinks daily out of his horse-pond; how a Skye crofter may be very healthy, though the filth inside his dwelling beggars description; how smiling English villages produce rosy faces year after year, while their drainage is unspeakably bad. Let the epidemic once come, let the poison-germ be once imported into horse-pond, dwelling or drain, and see then how much the old boast will be worth that people have lived here healthily enough for twenty years past.

Exactly the same reasoning applies to each house. That people in a house have not been ill does raise a presumption that the house is healthy, but this presumption is no proof until the house has stood the test of contagious illness in the neighborhood. If *then* the inmates escape, there is good reason to believe that the house is cut off from poison-germs arising outside; still, the house, though faultless as regards the outside world, may have such defects in the

internal system of fittings, that if one inmate be ill, others living in the house cannot escape contagion. A house which passes the double test successfully, of illness without and illness within, may receive a first-class certificate as being healthy; but these tests cannot be conveniently applied, and are, moreover, not conclusive against a house which fails to pass them, since contagion may spread in modes wherein the house is not to blame. We must, therefore, not argue rashly from the healthiness or unhealthiness of the inmates as to the excellence or defects of the sanitary arrangements.

The objects we aim at must then be to exclude poison-germs from without, and when they arise within, to prevent them from spreading within the house or remaining there. Poison-germs enter from without chiefly by the agency of sewer-gas and drinking-water. This is the result of long experience. It is well ascertained that serious illnesses may be contracted by breathing air containing an almost infinitesimal quantity of tainted gas. The word *tainted* is here not applied to simple sewer-gas, which is injurious but not poisonous, but to sewer-gas which is poisonous, because it contains germs which have arisen from matter

2

more or less directly connected with a person suffering from infectious illness. Simple sewer-gas is little worse than a bad smell. Tainted sewer-gas may be so poisonous that a very little introduced into a bedroom—so little as to be quite imperceptible to the nose—shall certainly give typhoid fever to a person sleeping there. The germ is a spark the effects of which may be unlimited. We do not content ourselves with excluding the great majority of sparks from a powder-magazine; we do our best that not one may enter. So our endeavor must be that not one germ shall enter from a tainted sewer into our house-drains.* All town sewers must, moreover, be treated as tainted, since

* It is not unusual for a householder, unless his house fairly stinks, to consider it "as sweet as a rose," and to rest happy in the conviction that it is perfectly healthy. The truth is, that a foul odor is not in itself poisonous. When it exists in a house, it indicates a source of foulness which *may* also be a source of disease. But, unfortunately, the source of disease may, and often does, exist without obvious bad smells. The fainter odors which more often accompany dangerous emanations are not perceptible to those who live constantly subject to them. To one fresh from the country they are almost always obvious in an average city house. The illustration of the single spark and the powder-magazine is exactly in point.—*Am. ed.*

at some time or other the taint is sure to arise. True, the germ may get into our house-drains and breed millions of other germs, and yet we may escape, for our internal fittings may be so perfect as wholly to exclude the hostile army; but who would be so foolish as, in a dare-devil way, to allow this army to lurk at every closet, at every sink, at every bath, in every pipe of our house, waiting at a hundred outlets for just one little opportunity to creep through, when he could bar the door effectually at one main entrance? To admit gas from the common sewer into the private drainage system of our house is to lay on poisoned air all over the house, with taps to draw it off placed about at random, with the hope that by no accident no single tap may ever be turned the wrong way. Surely one would think such folly could never be committed, yet not only is the practice common, being due to ignorance, but actually some modern sanitary engineers recommend arrangements by which every house is directly connected to the common sewer, trusting to the hundred little devices inside the dwelling to exclude the poison. It is doubtful whether a single town has yet made any regulation to insure that either new or old

houses should be effectually cut off from the common sewer. Yet isolation is the one main point in sanitary arrangements, as Dr. Parkes well knew.

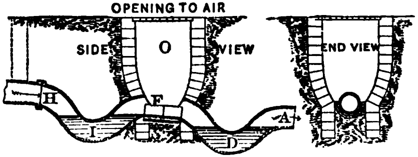

Fig. 1.—Trap between House System and Main Sewer.

Here, then, is our first problem: How shall we connect the internal drainage system of the house with the external drainage system of a town, and yet prevent the common sewer-gas of the town from entering the internal system of the house? Very simply. Water will run down an open channel, but gas will not run up one.* Whenever, therefore, we can turn liquid out into an open channel, and then from this channel take it by a second pipe to the common sewer, we may feel certain that, while liquid refuse can go out,

* This refers to a channel which is nearly level, not to a vertical pipe open at the ends.—*Am. ed.*

tainted sewer-gas cannot come in. If we trusted wholly to this simple plan, the open channel would have to be of considerable length, which would be objectionable, inasmuch as the matters conveyed by it must be unsightly. A trap at each end of our channel allows us to shorten the channel safely. Fig. 1 shows this arrangement. A trap is merely a generic name for any valve which lets water through, but stops gas or air. The simple S-bend shown in the figure is the most common and best example of a trap. There are many patented designs which aim at carrying out this principle, but Fig. 1 shows an arrangement which is perfectly efficient, and which can be carried out by any country mason. The water which lodges in the bend D prevents any gas at A from passing to F and O. The water in the bend I shuts off H, the internal system of the house, from the pipe F and opening O. It may be asked, Why is not the single trap D or I sufficient, without either the second trap or the open channel O? The answer is that a single trap is useful, but insufficient, because we know that traps are occasionally unsealed, to use a technical phrase denoting that in some way the water, which ought to seal up the passage, is either absent or forcibly

displaced. The water may dry up; it may run past with such velocity as not to remain in the bend; it may be sucked out by a mere rag lying over the edge; it may be forced back by pressure inside the sewer, in which a sufficient pressure is not unfrequently produced by various causes. The modes in which traps fail are easily shown by experiments, but a full description of these would require more technical treatment than is contemplated in this paper. The conclusion may, however, be taken as one thoroughly accepted by the engineering profession, that no single trap can be depended upon as certain to shut off sewer-gas; indeed, Dr. Fergus has shown that all gases slowly diffuse through water, but with the arrangement shown in Fig. 1 we have triple and compound security. Either trap alone will serve us when it is in good order, and the open channel will serve us if both traps are out of order. Now and then a germ might pass one of the barriers, for now and then one of the traps may be out of order, but the danger of communication with a tainted sewer is by this plan reduced to something inconceivably small. The open channel may be a mere length of pipe covered with a grate in an area; it may even be inside a house, but cov-

ered by a pipe led outside and open at the end. This channel open to the air may be looked upon as a kind of safety passage, diverting all danger. The longer it is the better, but a foot or two is sufficient. Let this channel be made, and disconnection is complete, so far as tainted gas from without is concerned.* Moreover, this channel can be inspected at any moment, to make certain that the house really is drained into the sewers, a matter of which one can never make certain when all the drain is covered in and out of sight. Many readers would be amazed if they knew the extraordinary number of houses in every town which are only nominally connected with the sewer, but really deposit all their filth on the soil on which the house stands.

The Mansergh trap, Potts's Edinburgh trap (Fig. 2), Hellyer's trap, and some others, aim at carrying out the open channel arrangement, but no special or patented trap is required, for the simple design shown in

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* This must be taken with some qualifications. The danger also exists that the "opening to the air" will become closed by snow or rubbish. Furthermore, it may become an inlet for currents of sewer air when both traps become unsealed.—*Am. ed.*

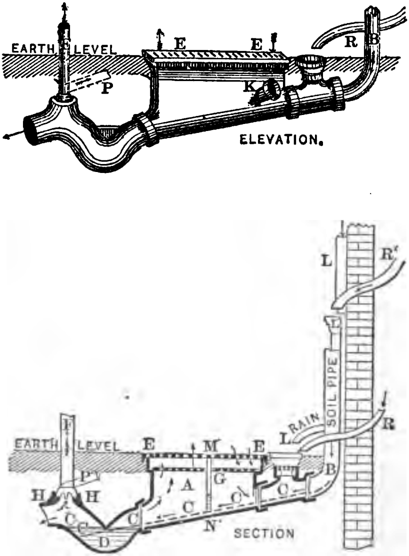

Fig. 2.—Potts's Patent Edinburgh Air-chambered Sewer Trap.

Fig. 1 answers our purpose. A cast-iron trap made by Messrs. Cottam, of Winsley Street, London, is perhaps the best of all the patented arrangements intended to carry out this principle, provided their charcoal tray is omitted, and the trap left quite open at the top, not closed by a so-called ventilating pipe. The present object is not, however, to recommend any one maker's trap, or to give technical knowledge, but to explain the exceedingly simple principle by which the isolation of each house from the common sewer may be insured. Let this be done, and nine-tenths of the battle is won. There is no novelty in the principle. The practice is comparatively rare, but has stood the test of experience in hundreds of examples.

The short piece of open channel is not offensive to smell or sight—the surface exposed is not larger than that of utensils which we keep in our bedrooms; the contents are less offensive, and it is placed out of sight and out-of-doors. It is essential that there should be a large opening at O; an opening by which the bends can be cleared when they choke.

When this principle has been carried out the house is exposed to no danger from sewer-gas, except from that which is generated

within the house, and which will not be tainted except when contagious illness is present there. Nevertheless all the fittings in the house must be such as to diminish, as much as may be, the amount of sewer-gas arising from the internal drains, and to exclude it from the air we breathe and water we use.

To explain in detail how this is done is foreign to the purpose of this article; the general principles, however, are simple.

The internal pipes of a house should be divided into four groups (exclusive of the gas-pipes). These four groups are shown in four different colors in Fig. 3. The pipes colored red are those which receive foul matters, such as would certainly be tainted when contagious disease occurs within the house. No pipe of this system should ever end or begin in or near a dwelling-room. Every opening into this system must be considered with the most jealous care: the traps used to close these openings must be of the best design, easily examined and specially ventilated. The whole system should be freely open to the air, and should indeed be aerated by a thorough-draught, for abundance of air prevents the formation of sewer-gas. This aeration may be effected by a

set of pipes like those shown in blue. It is not necessary that this system should always be arranged exactly as drawn; for instance, in many cases the red pipe may be open directly to the air at X, but this can only be done with safety and convenience when the opening is far away from a dwelling-room, for this opening, unlike that at O, would allow gas generated over the whole area of the red system to blow out through it. Special arrangements may be made to prevent this, but the main principle is thorough isolation of the contents of the red system, and thorough ventilation of that system. The second system of pipes is that colored yellow; this system receives all liquids which may be called dirty, but not foul—the water from baths, kitchen sinks, and wash-hand basins. This group is carefully isolated from the red group, and its contents only join it after running a short way through an open channel at C. This open channel may be placed so as actually to be seen, for the liquids passing are not offensive to the eye; the overflow-pipes from water-closet cisterns enter this yellow system. The water-closet cistern is always exposed to some risk of contamination, and must not be treated as containing pure water. It must not,

however, be exposed to the great risk of contamination involved by putting it in connection with the red system — in fact, no opening into the red system should ever be made which can be avoided.*

Last comes the black system of pipes, which are intended to contain perfectly pure water—water to drink, to wash in, and to cook with. This system includes not only the pipes bringing the water into the house, but all pipes running into or out of cisterns containing pure water. This last-named point is the second cardinal feature in any system of domestic drainage: the first is isolation from the common sewer; the second is isolation of the drinking-water from every suspicion or breath of taint.

A cistern to contain drinking-water should not be anywhere near a water-closet, nor in a bedroom: no pipe whatever leading from it or to it should on any pretext be allowed to communicate with the red system, nor, if it can possibly be avoided, with the yellow system. The overflow-pipes, as they are

* With the best American workmanship, the constant American practice of making the *red* and *yellow* systems in one is entirely safe, and its simplicity and economy commend it.—*Am. ed.*

called, must only communicate with the red system by means of an open channel.

An infinity of small details should be attended to by the designer of a system of house-drainage, to insure ease of inspection and repair. There are good traps and bad traps, good water-closets and bad ones, good taps and bad taps. There is the question of proper materials for pipes, cisterns, joints, etc. There is the drainage of the subsoil, the dryness of the walls; and, in fine, hundreds of small technical points which none but professional men can be expected to master; but strangely enough these minor points are far more watched and written about than the main points of the system, as set out in the diagram. If extra fittings, such as hot-water pipes for warming or washing, are required, we have only to consider whether they belong to one or other group—red, yellow, or black. If by any chance the water can be used or misused for drinking, cooking, or washing, let the new pipes communicate exclusively with the black system.

If the new pipes are pipes for draining the soil, have a good care that these are kept either wholly separate from the red system or are separated from it by an open channel.

The diagram given represents an ideal system, but one which can frequently be carried out with very little difficulty even in old houses. Certain points are moreover of much greater importance than others; the two imperatively necessary conditions are that the drinking-water shall be subject to no manner of taint, and that no wash-hand basin, bath, or any other contrivance in a bedroom be left in direct communication with the red or foul system. This must not be understood to mean that there shall be no wash-hand basins with waste-pipes taken from them in bedrooms, but merely that these waste-pipes must not be joined directly with what are called the soil-pipes, *i. e.*, with the red system. Our ideal system does, however, absolutely exclude water-closets from bedrooms. Of late years architects have introduced this most pernicious convenience into some of the newest and largest houses. This fact alone helps to explain why typhoid fever has increased among the wealthy classes.

Some readers may suppose that the diagram shows an arrangement of great complication, but this is far from being the case. So many pipes are absolutely necessary, and are actually provided, in a house, that any

drawing showing them looks complicated. The appearance of simplicity is obtained in our dwellings by the inconvenient and pernicious habit of burying all pipes out of sight and out of mind, in walls, under floors, and behind wainscots. In some parts of a house the pipes must be concealed, but that ready access to them should be possible is most desirable.*

It must surely be clear that no very great expense is required to put in a simple disconnecting trap between the main sewer and the drain, and to separate foul pipes from those which should be clean; but while small expense is required, considerable care, common-sense, and even technical knowledge is required to carry out the simple principles laid down—and this technical knowledge and common-sense are not easily found. Moreover, let the drains and water-supply of a house be as well designed as is possible, we are nevertheless at the mercy of a careless workman or ignorant contractor. Of what use is a good design, if the

* I am of opinion that rain-water pipes should not be used to ventilate the red system, and should only communicate with that system after passing an open trap.

pipes are ill laid, with bad levels, with open joints, or no joints at all? The writer has seen some cases, and heard of far more, in which the drain-pipes, when examined, presented a series of faults almost like geological faults: short pieces of vertical pipe stuck in at odd places, up which the sewage was supposed to run, but where a choke inevitably occurred; gaps open to the soil under the house, through which the sewage ran, making a horrible morass of the foundations—even slates put to block up the end of a drain which was supposed to lead into the town sewer. It will be supposed that these cases are rare exceptions. Unfortunately these cases of bad workmanship are common, and not rare. A plumber neglects to solder a joint, or he does it badly, and the pipe passing behind the wainscot, though well arranged by the architect, year after year pours out its supply of poison. We require, then, not merely a good design, but also thorough inspection of all work executed. In practice the inspection is very imperfect. The Burgh Engineer and his staff do, in large towns, take care that the junction with the main sewer shall be properly made, and this is at least something; but it is not possible for them, unless their numbers be consider-

ably increased, to inspect the complete sanitary arrangements of every house while it is being built; and yet without this complete inspection we really have no security. The inspection hitherto given is a mere tithe of what is really required.

Still further, let us suppose that the sanitary arrangements in a house have been well designed, and the work well executed, nevertheless, without continual skilled inspection no safety is to be had.* The case is analogous to that of the use of a steam-boiler. This boiler may be well designed, well made, and properly used; nevertheless, day by day it decays, and in course of time must wear out; then comes explosion and loss of life. This is no fancy picture; the fact became so patent that more than twenty years ago Associations were founded for the systematic inspection of boilers. This inspection is resorted to by every conscientious user of steam-power, and in *their* factories it has practically abolished explosions of this

* The foreign practice of using lead for soil-pipes, so common abroad, justifies this. With enamelled cast-iron pipes, properly jointed, the inspection may be confined to the short lead branches; for the iron-work is practically permanent, and *every hidden* pipe should be of enamelled iron.—*Am. ed.*

class. Now, drains, lead and iron pipes, cisterns, valves, traps, and all the sanitary arrangements of a house, are as subject to decay as the steam-boiler. Their decay is more fatal than the rust of the iron boiler plate, or the wasting away of the boiler stay. For one life lost by boiler explosions, hundreds are lost by the decay and wasting away of our sanitary appliances; and yet systematic inspection of drains and pipes in our houses is to-day almost a novel idea, and a wholly novel practice.

The decay and failure of drains and pipes is especially dangerous, because these are invariably out of sight. The lead or iron pipes are gradually eaten away, until large holes admit sewer-gas behind the panelling and so into our bedroom; yet no greater warning is given than a slight closeness in the room. Drains crack underground as old or new houses settle, and the sewage pours into the basement.* The servants complain of rats and bad smells, but the evil grows so slowly that we are not forced

* The use of underground drains should be avoided so far as possible. It is better to use an iron pipe fully exposed to view. When underground drains are used, they should be made absolutely indestructible.—*Am. ed.*

into action on any one day. Cement crumbles away from joints originally well made, and then, at the junction perhaps of an expensive leaden pipe with a well-laid drain, we have a hole big enough to put a hand through, and up through this hole, day and night, sewage-gas pours into the house; yet, as in a case lately seen by the writer, the house is considered remarkably sweet.* The ventilating openings carefully provided by the architect or engineer are closed by dirt, by careless or ignorant servants and workmen, or even by birds' nests, and no one is at all the wiser until disease breaks out. Not unfrequently the passage of the sewage through the drains is wholly interrupted by the mere accumulation of kitchen grease or rags; then, while the sewer retains the solid filth, the liquid oozes out at every pore, and yet no harm is suspected. These accidents are samples of ordinary and inevitable decay, even when work has been well designed and well executed. There is but one safeguard — systematic inspection. To insure a healthy house, we must not only design the drains and pipes well, see that they

* Such work as is here indicated is quite inadmissible. Use only iron pipes inside the house.—*Am. ed.*

are well executed, but we must have them systematically inspected. Now, to do these things requires professional skill; and the one question therefore is, How can the ordinary householder command this skill? Some say that the municipality ought to provide the advice for him, and to some extent this is undoubtedly true. The local authorities ought to require that all plans for sanitary arrangements in new houses should be approved by the Burgh Engineer. It should also be the work of this official to inspect the execution of the work; but in order that this municipal guarantee may be efficient, it will be necessary both that the standard of excellence commonly required by the town authorities should be considerably raised, and that the staff and powers of the Burgh Engineers should be greatly enlarged. When, however, we consider a house which is already occupied, the difficulties of municipal inspection become very great, and the right of the occupier to gratuitous services very doubtful. Public authorities must, in the interest of the community, superintend the design and construction of new houses built to be sold, because no one individual has, at the time of their erection, any special interest in these

houses, or any right to interfere. But from the moment that the house is occupied, the occupier, so long as he does not injure his neighbors, has a right to arrange the interior of his dwelling as he pleases, and the law would have great difficulty in enforcing good sanitary arrangements simply on the plea of constructive injury to others. Even if the householder demanded the interference of the municipal authorities gratis, it is rather difficult to see on what plea he could claim engineering advice gratis more than medical advice, or, indeed, more than good food and warm clothing. The municipal action apparently must cease at the point where the general interest of the community ceases to be paramount, and as a rule this general interest ceases outside of each house-door. This principle must not be pushed too far; and the writer would gladly see a more stringent and more methodical inspection of dwellings by local authorities, but he fears that any agitation in favor of this reform will produce extremely small and inadequate results. At present no one is prepared to recommend that the town shall undertake the duty of annually inspecting every house, and of superintending every alteration in the sanitary arrange-

ments of each house. Nevertheless, without systematic inspection safety cannot be secured, and the question arises, Can we by our own action obtain the supervision we require? Thinking over this difficulty, the idea naturally occurs that what the steam-users do for boilers, householders may do in respect of houses. Men can by co-operating do cheaply that which would be costly if each person were to act independently. Let us then have a Sanitary Protection Association.

Let each person interested in a dwelling subscribe his annual guinea. With the funds so collected let a staff of competent engineers be engaged. Let each member obtain from the Association a report as to the condition of his premises, with an estimate of the cost of any improvements recommended; then let the member be quite free to carry out the recommendations or not.

In any case, let him secure annual inspection of his premises by his annual payment. If the improvements have been made, these annual inspections will secure the permanent efficiency of his arrangements. If he has not chosen to make any improvements, the annual inspection will at least tell him whether things are getting worse.

An Association having these ends in view is about to be formed in Edinburgh. Started under good auspices, this Association will enable the idea of voluntary inspection to be fairly tried. The Edinburgh householder is intelligent, and as a rule aware of the importance of good sanitary arrangements.

The engineers who make the inspections will be young men, such as form the active staff of an engineer in good practice. They will be directed by a consulting engineer and by an elected council. The council and consulting engineer will lay down the general rules on which the recommendations of the Association will be based. The resident engineers will apply these general principles to particular cases.

The nature of the inspection, and the means by which it can at once be made efficient, and yet simple and convenient, will be explained in a future lecture. Meanwhile it is sufficient to say that annual inspection does not mean the disturbance of a house from top to bottom, and does not require that every inch of pipe, or indeed any inch at all, should be laid bare to the eye. By a little ingenuity, tests of great severity can be easily applied from time to time, at a very trifling cost and with no inconvenience.

Each member will carry out any alterations suggested by means of his own tradesmen, but the soundness of the work done will be inspected by the Association.

It is clear that the recommendations as to alterations must be moderate. It is very desirable that in new houses every conceivable improvement should be introduced, but in old houses we cannot possibly prevent drains from running under the house.* We cannot rearrange the rooms, we cannot build chimneys for water-closets, nor must we banish fairly good old fittings, although, if we were beginning afresh, we might possibly employ newer varieties.

Some recommendations, which are met with even in good books on sanitation, are almost droll in their severity. We wonder whether Mr. Eassie follows his own recommendation, and over every gas-flame in his house places "a tin or zinc tube above each burner, so that these tubes convey the products of combustion into the open air." He says this is so well understood that it is

* We here often do prevent their running out of sight under the cellar floor, and bring them up to the light where they can be inspected, which is an immense gain.—*Am. ed.*

hardly necessary to mention it; but he does not remind his readers that in many cases, as where a light is on a swing bracket, the plan is quite impracticable, nor does he mention that where practicable it is hardly ever carried out.

Again, Dr. Parkes says the products of combustion are for the most part allowed to escape into rooms, but *certainly this should never be allowed.* Now this was an excellent recommendation with reference to new barracks and similar buildings, but Dr. Parkes would have shrunk from laying down such an absolute law as this if he were asked to say that he really meant that it was necessary to take out almost all the gas-fittings in Edinburgh, and substitute for them the costly apparatus by which the products of combustion are kept out of rooms.

Again, as to the usual recommendation that no drain shall ever pass under a house, the rule is an excellent one, but absolutely inapplicable to old houses, and even to most new ones. The worst of putting forward these excessive demands is that the public naturally look on all sanitary recommendations as of equal weight; they know that they habitually burn gas in their houses without a ventilating tube over each flame;

they know that they use old-fashioned water-closets instead of Jennings's newest patent; they sometimes know that the drains do and must pass under their houses; they observe that these things are done with impunity in most cases, and hence they draw the conclusion that other recommendations which are really vital may be disregarded. Thus, when they read that no waste or overflow-pipe from a drinking cistern must on any account communicate with a drain, they let the recommendation go in at one ear and out at the other, although the importance of this is a hundred-thousand-fold greater than that of the recommendation about ventilating tubes for gas-flames.

The Sanitary Protection Association will stand face to face with facts, and will not be able even to lay down, much less to enforce, impracticable suggestions; the few really important points will in this way be made to stand out in bold relief, and be brought prominently to the notice of the community. Hitherto sanitary questions have been too much in the hands of officials, on the one hand, and patentees on the other. The official felt bound to recommend general principles of the greatest rigor, so that no critic might spy any defect which he had omitted

to censure; at the same time he was bound to apply those principles with the utmost laxity, lest the members of the community should cry out against oppression. Thus the positive laws enforced in any case are as ludicrously below the real necessities of the case, as the ideal held up before us is beyond them. As for the patentee, he of course advertises his own invention, as he has a right to do. In many cases the advertisement is a fair and honest one, but we cannot expect any manufacturer to make it his business to give disinterested advice about things in general; he does his duty if he tells the facts about his own filter or trap.

It is hoped that Associations like that now started in Edinburgh may be formed elsewhere, and that the public may be found ready to act on skilled advice when given by engineers holding the same position toward their clients as the engineers of companies hold relatively to their share-holders. The council of an Association, elected by the members, can have no object but that of engaging the best engineers they can find; and being themselves householders, and well acquainted with the town where the Association is formed, they will be certain to prevent any fanatic from suggesting extreme

measures. Plumbers, builders, and other sanitary manufacturers will find the establishment of these Associations to their interest, for they will have to carry out all alterations and improvements recommended; at the same time, the householder will have the satisfaction of knowing that the tradesman is working under skilled inspection.

Lastly, the father of a family, when he has carried out the recommendations of the Association, will be able to sleep in comfort, with the knowledge that he has done his best to procure and act on competent sanitary advice. Each time that he comes back from the country he will know that the responsibility of seeing that cisterns are clean and drains in working order no longer rests on him. The inspector has been round, and reports that every reasonable precaution which common-sense and technical knowledge can suggest has been taken.

Associations of this kind may also greatly benefit the poorer classes of the community; but this second aspect of the work requires a separate lecture.

NOTE.—The theory on which the formation of the Association is founded is entirely sound, and the argument is very fairly stated. At the same time, such a movement cannot now be initiated in a small town

(in the present state of interest on the subject) with any confidence in a justifying success. Like the official who feels "bound to recommend general principles of the greatest rigor," and at the same time "to apply these principles with the utmost laxity," the Association would find a wide difference between its enunciations and what its members would stand. If the larger cities would lead off in the work, and establish, *by their practice*, the rules which smaller communities should follow, then every considerable town could safely undertake the work. With adopted and successful rules for their guide, they could be kept up to a good standard. Where a membership large enough to furnish the needed funds must include many persons of small means, the inevitable tendency—in the absence of a working example—would be to let the separate overflow-pipe of the cistern go with the ventilating tube over the gas-burner, and to insist only on an absence of actual filth.—*Am. ed.*

Lecture II.

PART I.—VENTILATION AND WARMING.

CERTAIN scientific principles in connection with ventilation have long been well understood. We know quite well that any large quantity of carbonic acid gas in the air is deleterious; that six volumes of this gas in 10,000 parts of air is the extreme allowance which the sanitary engineer will tolerate, and that it requires a supply of no less than 3000 cubic feet per head per hour of pure air from outside to keep the inside of a room up to this standard of purity. Mountain air has about 3½ parts of this objectionable gas in each 10,000 parts; town air, about four parts. Nine parts per 10,000 make a decidedly offensive mixture; and at the top of a moderate-sized room, in which two people are sitting with three gas-jets burning, we may find as many as sixty or seventy parts of carbonic acid gas per 10,000 parts of air.

If, again, we consider the useful part of the air, oxygen, instead of the deleterious part, carbonic acid, we find that mountain air has 2099 parts per 10,000. In town this

falls to 2096. A little less than this makes air bad; and when we have only 1850 parts of oxygen in 10,000, the air will extinguish a candle. The engineer can calculate the rate at which, with given differences of pressure, air will flow in through given openings, and he can also observe that at temperatures of 55° or 60° a draught means a current of more than 2½ feet per second; but these scientific facts, with many more of the same kind, while useful in designing large works, and to those who control the ventilation of schools, theatres, hospitals, and so forth, are of little use to the unskilled house-occupier, and it is to these that the present lecture is addressed. It is not every one who can measure the influx or efflux of air in cubic feet, or ascertain the chemical condition of the air inside a room.

Most of us, however, can ascertain the simple contents of a room; and the following table, showing the space per head which various authorities allow in living and sleeping rooms, are immediately interesting:

	Cubic feet.
Ordinary middle-class house	800 to 1000
London Board schools	130 "
London lodging-houses—dormitory	240 "
Poor-Law Board	300 "
Barracks	600 "
Wooden huts for soldiers	400 "

The allowance in the London Board schools is somewhat misleading. The number actually present is, of course, never equal to that for which accommodation is nominally provided. The practical application to be drawn from this table is, that each householder should examine the space given per head in his servants' and children's bedrooms. The allowance of the Poor-Law Board would allow two people to sleep in a room ten feet high, ten feet long, and six feet wide—no very excessive allowance of space; double this amount of space is certainly desirable.

In a house of ordinary size, it is much easier to warm and ventilate a large room than a small one. It is clear that in a small room the necessary supply of air cannot be introduced except by coming in and going out with such velocity that a draught is felt. Besides this, any little want of adjustment in the supply of air or warmth makes its consequences much more rapidly and seriously felt. It is hardly possible to adjust the fire or stove in a small room so that it shall never be too hot or too cold, or so to regulate the supply of air that the room shall never feel stuffy or draughty. For those who can afford it, ample space in

the dwelling-room affords the best security for good ventilation. Air is withdrawn by large fires, and comes in at every hole in the walls, and at every chink in the doors or windows, even when these are habitually closed. Indeed, in our best houses the question of ventilation hardly arises unless under exceptional circumstances; as, for instance, during a party, or whenever much gas is burned.

For those who live in small rooms the question is, on the contrary, of much importance, for close rooms mean liability to chest-disease and to continual poor health. By introducing proper ventilation into barracks, Dr. Parkes is believed to have reduced the mortality due to lung diseases in the Guards from 12½ per 1000 to 1½ per 1000 per annum. We are never so liable to catch cold as when just leaving a vitiated atmosphere. Headaches, a feeling of stupid sleepiness, and general debility, are well-known results of close rooms.

As a rule, a healthy man may trust to his senses as to whether a room is close or not; this is especially true if the test be made of occasionally going into the open air, and then returning to the room the condition of which is in question. If the vitiation of air

proceeds gradually, our perception of its final condition is far from being so keen as that which we have on suddenly being confronted with the foulness. This is not only true from hour to hour, but also from year to year. Men and women who habitually live in a foul, close atmosphere, gradually become so much accustomed to the pollution that they prefer the close tainted smell to fresh air, even when this is warm. The freshest breeze of spring suggests draughts to people in this condition. School-masters are especially subject to a vicious taste for foul air. Both they and the children suffer cruelly in consequence.

The writer knows of a case where a school-master in a good school not only shut all the doors and windows, but actually stopped up the fireplace to prevent draughts in fine spring weather. Of course his health was not good.

Before describing various systems of ventilation, it will be well to consider what conditions of air and warmth are pleasant to a healthy man. Most people will allow that they feel in the very best condition of health and cheerfulness out-of-doors, in the country, on a still, sunny, spring morning, when there is a slight frost in the air, al-

though the sun has already made every stone on the hill-side almost warm and quite pleasant to the touch.

Under these circumstances we lose no heat by radiation. The sun is so bright and warm as to give us back all that we give out. We lose no heat by convection; that is to say, no heat is carried away by air blowing past us. We therefore remain warm without exertion, and even when lightly clad. At the same time, the air we breathe is brisk and fresh, almost cold, and this air is far pleasanter than the same pure air on the same hill-side after it has been well heated in the afternoon. Writers on ventilation are too apt to forget that we like cool air to breathe just as we like cold water to drink. Neither lukewarm water nor lukewarm air are palatable; we only submit to these when we can get nothing better. There may be exceptions in the case of illness requiring air to be supplied with the chill off, but as a rule not only does foul air cause people to cough more than fresh air, but warm air produces fits of coughing which cold air allays.

It is quite unnecessary to dogmatize on the subject, and it is impossible to name any one temperature as the most suitable

for all persons or all circumstances; but the description given above of the pleasantest condition of heat and warmth thoroughly justifies our national love for the open fire as compared with the close stove—an open fire warms us by radiation as the sun does, a close stove warms us by supplying us with warm air, which is a less healthy and pleasant condition, however the heat be produced. No one who is disinterested will say that he prefers the puffs of lukewarm but pure air which meet him in a well-ventilated and warm church to the glow of an open fire. The difference is acknowledged; but the superior attraction of the open fire is usually set down to old associations, and so forth; in reality, it is in great part due to the difference between heating by convection and by radiation. Another advantage of the open fire is the ventilation which it insures. We often hear of the waste heat from an open fire, and are told that nine-tenths or more of the heat goes up the chimney (which is true), and is consequently wasted (which is false). This so-called waste heat really fulfils the very important function of driving the vitiated air of a room into the atmosphere, and sucking pure air in from outside. The air required to

support combustion is all that the close stove withdraws; the open fire, on the contrary, besides the air which is burned, sends a great volume of unburned air up the chimney. Now this air going out implies a corresponding quantity coming in, and shut doors or windows as we may, the fire of an open fireplace will suck in fresh air in considerable quantities, even through the very walls of a room. A good fire will cause from 6000 to 10,000 cubic feet per hour to enter and leave a room.

It must however be remembered that this best mode of warming is not the cheapest, and is indeed so costly as to be impracticable under many circumstances. Large school-rooms, churches, and so forth, cannot practically be warmed by open fires, and our dwelling-houses are warmed by these fires at much greater cost than would insure the same amount of heat, if not the same comfort, with other contrivances. Moreover, although an open fireplace almost insures ventilation, it is not the only mode of ventilating, so that it may be very proper in many instances to adopt other contrivances for warming and ventilation. The following series classifies the modes of warming now in use, in the order of their merit or demerit, in the opinion of the writer:

1. *Worst.* A gas stove with no chimney. This mode of heating consumes air and removes none of the products of combustion, which remain to poison the apartment. It warms by convection, not radiation. It is also costly.

2. *Very bad.* An iron stove raised to a great heat, and having but a small exposed surface. These stoves may often be seen red-hot. Air which passes over a very hot surface acquires a peculiar smell and taste, perhaps arising from charred organic matter; but whatever be the cause, the dry, foul taste is easily recognized. Moreover, the gases inside the furnace pass readily by diffusion through red-hot iron. Smoke is not seen to pass from stoves of this kind into a room, but many products of combustion do come through the iron shell, and are easily recognized by their smell. The sulphur in the coals is always smelled in any room warmed by a stove of this kind. It heats by convection. Its one merit is cheapness.

3. *Bad.* A cast-iron stove heated moderately. When the surface of an iron stove is very greatly increased by gills, as they are termed, or otherwise, the heat of the surface is much reduced, and the action of the stove

considerably improved; the air outside the stove is not charred or dried to the same extent; the injurious gases cease to be diffused through the shell, and under some circumstances stoves of this class may be employed. They produce considerable heat at a moderate cost.

4. Hot-air pipes have one advantage over the best cast-iron stove — they cannot be so readily overheated. They also can easily be arranged so as to distribute the heat more uniformly throughout a room or hall. They are more costly than the stove.

5. Porcelain stoves moderately heated are better still. In the first place, they are never made so hot as an iron stove may be; and, secondly, air passed over hot bricks is not so much spoiled as that which is passed over hot metal. The writer does not know the cause of this, but the fact is generally admitted.

6. Hot-water pipes are better than any form of stove or hot-air pipes. The surface exposed to the air is simply warm to the touch, and does not in any way injure the air. Whether therefore the air to be heated is actually in a room, or is introduced into the room after it is heated, hot-water pipes are to be preferred to any form of stove.

When, however, air is introduced into a room heated in a separate chamber, hot bricks supply a better warming surface than hot metal.

In all the modes of heating so far, convection by air has been the only means of distributing the heat. This in itself is a disadvantage. Moreover, we must provide, in every case hitherto considered, openings by which vitiated air can be withdrawn, as well as openings by which pure air may come in. These openings are too often absent.

Some excellent open fireplaces are made which introduce warmed air into the room by passages above the fireplace. The air is warmed sometimes by bricks, sometimes by metallic surfaces, at the back of the fireplace, and is drawn from outside the building. The Manchester School Grate, as it is called, is a good example of this type of fireplace. For many purposes this mode of warming is the best. It has the merit of heating in part by radiation, and of providing a considerable opening for the withdrawal of foul air, and with this merit it combines that of heating more cheaply than the ordinary open grate, because it in part depends on the action of convection, which

is the principle on which the cheapness of the close stoves depends. Moreover, if it does not supply the room with brisk cool air, it at least does secure a supply of untainted air without a draught. This kind of grate is therefore specially suited to schools, public halls, and similar places.

The usual open fireplace appears to the writer to be the best of all for the ordinary dwelling-room. But the meaning of the word *best* must not be misunderstood. The common fireplace, with a plentiful supply of cold air direct from the outside, requires a considerably larger quantity of coals to be burned than would be required to give the same temperature with a Manchester grate. It does not prepare the air admitted into the room at all, and in some cases this will be a disadvantage, not an advantage. Where, however, the air is admitted by proper openings, so as to cause no draughts, unprepared air, fresh as it blows over the fields, is preferred by the writer to the most carefully filtered, doctored, damped, and warmed air which the sanitary engineer can supply.

Where no gas is burned, there is little need of any special mode of ventilation in an ordinary dwelling-room. Dr. Hinckes Bird's plan, Fig. 4, may be very useful in cases where

a draught is experienced from having the window open at the top or bottom. This plan consists in opening the bottom sash two or three inches, and then filling up the opening with a piece of wood, A, cut for the pur-

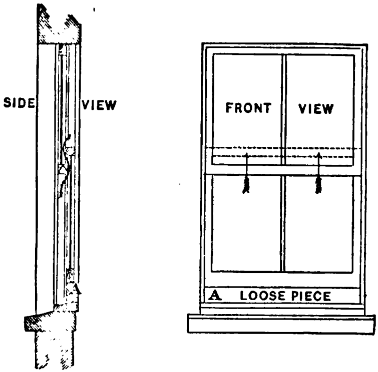

Fig. 4.—Dr. Hinckes Bird's Plan.

pose. This leaves no visible opening to the outer air, but there is in fact a considerable inlet between the two sashes, and the air which comes in there is directed upward, and shoots well into the room over the heads of

the inmates. It then diffuses in all directions, and is not felt as a draught. A draught may be defined as a thin current of cold air, with well-defined edges, passing through a still mass of sensibly warmer air. A draught will always be felt if the opening which admits air allows it to strike the inmate at once with the velocity it acquires on entering; the opening therefore must be so placed that the first rush of the air shall take place in that part of the room which is unoccupied, that is to say, more or less near the ceiling. Dr. Hinckes Bird's plan fulfils this condition whenever the blind is not pulled down over the sash or the curtain drawn. Either of these things defeats the object of the arrangement.

When a draught is felt, this should be taken as evidence, not that too much air is coming in, but that it is entering at the wrong place. We ought no doubt to stop up the offensive inlet, but not without providing another. The usual inlets in winter are the chinks round window-sashes and round doors, also the pores of the brick walls, and often the chinks in the floor. Who has not seen the carpet lifted off a floor by the pressure of air beneath? and who has not suffered from this most intolerable mode of

supplying the necessary air? Let this always be stopped, but provide some other inlet; very often the simple provision of this second inlet will stop the objectionable draught far more than thick carpets, or brown paper and putty, far better too than double windows.

The one question is, *Where* can we admit

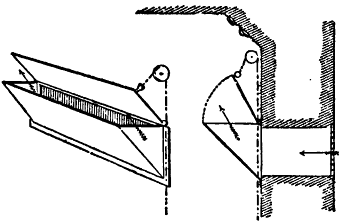

Fig. 5.—Sherringham Valve.

cold and unprepared air so that no draught shall be felt? The answer is, Anywhere above the level of our heads, provided the current is directed upward. We have seen that Dr. Hinckes Bird's plan solves the problem to some extent, but that the action is liable to be spoiled by such simple and necessary contrivances as a blind or curtains. We

must, therefore, in permanently draughty rooms, go more expensively to work.

Any dwelling-room of ordinary size can be supplied with air enough by means of a moderate-sized Sherringham valve placed near the ceiling. Fig. 5 shows a sketch of this arrangement. An opening is made through the wall, either by means of perforated bricks or by a simple passage, covered on the outside by a grating for the sake of appearance. Inside the room there is a small shoot, as it may be called, the object of which is to direct the air upward. This shoot must be closed at the sides and open only at the top. A small door or valve should be provided by which the top can be closed, or partially closed, in exceptional weather. A valve of this kind, 9 in. × 3 in., will keep a room of 14 ft. × 14 ft. quite fresh from year's end to year's end. It will be found desirable to close the opening during extremely cold or extremely windy weather, not because a draught is more felt, but because of the difficulty of keeping up the temperature of the room when a very large quantity of air, or very cold air, is admitted. The simple opening in the wall without the shoot always causes draughts. The cool air admitted seems to cling to the wall, and

trickles down as if it were so much cold water. This *douche* of descending cold air is often felt in churches by those who sit next the walls when windows above are open. In dusty places a considerable amount of dust comes in through an open Sherringham valve, and this dust marks the ceiling above it. A strainer of muslin is of some use in keeping dust out, but it ought to be frequently renewed, or the action of the ventilator would be much impeded. The writer is averse to the introduction of contrivances which require continual care and renewal, especially when these contrivances are situated in places not easy of access. He therefore prefers to submit to a little dust, except in cases where there might be a reasonable fear that the dust would spread infection.

Influx air-valves, of the type recommended, are advertised by Mr. Richard Weaver, of Clapham Road. It may save trouble to purchase valves ready made, but any house-joiner can make a Sherringham valve which will serve all necessary purposes.

In rooms where a very large number of people habitually sit, or where a large quantity of gas is burned, more air is required than can be supplied without draughts by a single Sherringham valve. In these cases

the vertical tubes, commonly known as Tobin's tubes, form probably the best channel for introducing the supply. Large, square wooden pipes are placed in the corner of the room, where they look like pilasters cut short, and communicate at their lower end directly with the open air. The upper end stops about seven feet from the floor, and can be closed at will. Two tubes of this kind, 5 in. × 5 in., will keep a good-sized club-room fresh. Their action depends, like that of the Sherringham valve, on the momentum of the incoming air, the rush of which is so directed as to carry it well away from those parts of the room where we sit or stand into the great vacant space above our heads, where it is dispersed by currents, and by diffusion, without causing inconvenience.*

There are very numerous plans for ventilating rooms by means of double openings, often placed close together; the air is supposed to come down one opening and to go up the other. These schemes, however, usually involve a greater cost than the

* A device much used in this country, by which air is admitted by upward turning tubes, attached to a board placed under the lower sash of the window, is simpler than Tobin's tubes, less expensive, and essentially as good.—*Am. ed.*

Sherringham valve or Tobin's tube, and are, in the writer's opinion, less efficient. No doubt some exit must be provided for foul air, as well as some inlet for fresh air; but the common defect in our dwelling-houses is the absence of the inlet, not the want of an outlet, which is always more or less provided for by the chimney in every room. Moreover, it will be found that in all the two-way plans, as they may be called, the current will be occasionally reversed, even when gas is directly employed to send the current in one direction. If the amount of foul air formed in a room is so great as, during its passage to the fireplace, sensibly to injure the breathing air, a remedy will be found in the introduction of an Arnot's valve near the ceiling. Dr. Arnot's well-known contrivance allows the air near the top of the room, where it is foul, to be sucked directly into the chimney, but does not allow the smoke to be blown back into the room through the opening. The common Arnot's valve makes a disagreeable clicking noise. Mr. Crossley, of Halifax, makes a variety which is cheap and quite noiseless. Boyle's light mica valves, made by Comyn & Ching, Little St. Andrew Street, London, are also preferable to the common metal valve.—

Not uncommonly, when two openings are made in a room, with the intention that one shall serve as an inlet for fresh air and the other as an outlet for foul air, we find cold air coming in at both of them, to the annoyance of the designer and the inmates.

It is of course true that no ventilation can be obtained without a current, and a current requires two openings. A candle will go out in a large jar communicating directly with the atmosphere by a single tube of even ¾-inch diameter. Two smaller tubes secure a circulation, and the candle burns. But, as has been already explained, the chimney, unless the register is closed, provides one opening, and usually the best opening. Moreover, since the chimney runs up far above all other openings that can be made into a room, it sucks the air in through any number of other openings, just as the long leg of a siphon would suck water up into a vessel through a great many short legs reaching down into a reservoir.

The cause of the movement of air from one place to another is often misunderstood. We say, popularly, that light air rises and heavy air falls, and that since warm air is lighter it rises through cold air, and thus we look on the mere fact that air is hot as a

reason why it should rise. This view is extremely incomplete, not to say erroneous. The cause of motion in air, as in all fluids, is a difference of pressure between the air at two places. The air goes from the place of great pressure to the place of small pressure, for the very same reason as steam at high pressure rushes out of a boiler into the air, upward, downward, or sideways — its motion being infinitely little affected by the relation of its weight to that of the air. Cold air rushes up into a vacuum, or partial vacuum, almost as readily as it rushes down. Hot light air inside a closed vessel will rush down through an opening in the bottom, if the pressure inside the vessel is greater than the pressure outside. Well, then, if the pressure inside a room is less than the pressure outside, air will rush in whether we make the opening at the top or at the bottom. This is sometimes overlooked, simply because the differences of pressure are so small as not to make themselves evident to the senses. These differences of pressure can, however, be observed on a sensitive barometer, and are quite analogous to the differences of pressure which cause wind out-of-doors. Now, in a room where people are sitting, a fire burning, or where gas is lighted,

the pressure is always less than the pressure outside the walls. It is, however (except when the chimney smokes), greater than the pressure at the top of the chimney. The annexed sketch may roughly represent a room, D, with a chimney, B, and opening, A. Let there be a uniform pressure outside the

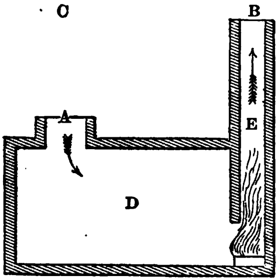

Fig. 6.

room at any uniform height, as at C B; then the pressure outside the room at A is greater than that at B by an amount due to a column of external air of the height A C. Inside the room, or rather inside the chimney, at E, on the same level as A, the pressure is greater than that at B, by the amount due

to a column of internal air of the same height, B E; but this second column is warm light air, whereas the first or external column is cold heavy air, so there is a difference of pressure between A and E due to the difference between these two columns of heavy and light air. Thus we have a high pressure outside at A, tending to send the air toward the low pressure at E. When we consider the room D we shall find the pressure near E, and a foot below A, just a little greater than that at E itself by the amount corresponding to a foot of light air; we shall find the pressure near A greater than A by an amount corresponding to a foot of heavy air, so that inside the room we find the difference of pressures required to produce a draught from the inlet to the outlet, and this would still be true no matter how many openings there might be like that at A situated below the level of B.

In plain English, the chimney sucks air in from every opening lower than its own chimney-can.

By burning gas under a short chimney we can indeed convert this short chimney into an outlet which shall suck even more vigorously than the long chimney supplied with tepid air by the fire. This we can do only

so long as the greater heat of the air in the gas-chimney more than compensates for the greater length of the fire-chimney.

The suction of the chimney, or difference of pressure, is very clearly felt every time we shut a door. If the window of the room be closed, we often have to pull a door to with considerable force. This force is the difference of pressure between the air inside and outside, multiplied by the area of the door. We may hold the door nearly closed, and feel this pressure as a most tangible reality. If the window, on the other hand, is open, the pressure inside the room will often be greater than the pressure in the hall, and then the door bangs to unless we oppose this internal pressure.

The suction due to the chimney is the cause of the inrush of cold air whenever a window is opened. It is almost impossible to prevent a large portion of the air supplied to a house from being drawn in through the water-closet windows. This is especially the case in cold weather, when other windows are shut. Even double doors are insufficient to keep this draught out. Every chimney in the house is sucking air in, and the water-closet windows are the only windows open, so the consequence is inevitable.

The remedy is to provide other less objectionable inlets, and if possible, to keep the water-closets in such good condition that we need not fear deriving a considerable part of our air-supply through these windows.

We receive a considerable supply of air through the very walls of our rooms. When these are of brick, and when the temperature inside and outside the room is sensibly different, the air coming through the walls may be sufficient for our wants. Pettenkofer got 2650 to 3320 cubic feet of air through the brick walls and crannies of his room, when the difference of temperature inside and outside was 34° F. When all the crannies had been very carefully stopped up, 1000 cubic feet per hour still came through the walls. Our thick freestone walls allow of less diffusion, and we must not trust to this source of air to the neglect of ample openings.* One important conclusion may however be drawn: we should never allow any mass of filth to accumulate against a wall outside a house, nor in any cellar separated from a dwelling-room by a mere partition; the smell and foul air will go

* Wooden walls, with sheathing-paper and "back-plastering" are still less pervious.—*Am. ed.*

through a brick partition almost as if it were not there. This smell will be particularly sensible *when the room is warm.* If we find that any room in our house becomes offensive in warm weather, we may reasonably suspect that the offensive smell is introduced by diffusion, and we may look for the source on the other side of partitions, floor or ceiling. Mr. W. N. Hartley mentions a case where a dust-bin on the other side of a wall made a small room unbearable whenever a fire was lighted in it. This filtration of air through an apparently solid material is easily shown by a very striking experiment, described in Mr. Hartley's book on Air, p. 97.

Where gas is not burned, special means of ventilating a dwelling-room are unnecessary, except under exceptional circumstances. When these arise, as during a ball, a large temporary Sherringham valve of canvas fitted into the upper sash of a window will allow it to be kept open if the curtains are not drawn. Where gas is burned, it is impossible to keep the air of a room sufficiently pure without special inlets other than the door, window, and chance crannies. Our senses give unmistakable evidence that a room lighted by gas is much closer, to use the fa-

miliar word, than one lighted by candles or oil lamps, and we need not suppose that science has reversed the verdict of our senses because the sellers of gas obtain a statement from some eminent chemist that *for equal light* gas fouls the air of rooms less than candles. This statement is probably true, assuming the gas to be of good quality and properly burned. But what does it mean? In Edinburgh we burn what is called 30-candle gas; that is to say, an Argand burner, supplied with five cubic feet of this gas per hour, gives a light equal to 30 candles, and an ordinary fish-tail burner, under the best conditions, burning three cubic feet per hour, would give light equal to 18 candles. It will appear to many readers that this is an absurd exaggeration of the light given by one burner in a room, but the gas company could easily show them experiments proving the claim to be absolutely true. In small rooms we frequently find three gas-burners alight, and in large ones six or seven, every evening. Thus the eminent chemist's statement amounts to this: When we light a small room with gas we produce less foul air than if we were to burn 64 candles in it, and in our large room the gas does less mischief than 126 candles. But then, who ever burn-

ed 64 candles every evening in his lodgings, or 126 candles every evening in his drawing-room? It is a little difficult to learn exactly how much heat and foul air a single gas-burner does really produce under ordinary conditions. There is an error on this subject in Mr. W. N. Hartley's excellent little book on Air, and its Relations to Life. The following more correct statement is based on letters received from that writer. According to Pettenkofer, a man yields from six-tenths to seven-tenths of a cubic foot of carbonic acid per hour. A good candle, according to Dr. Angus Smith and Mr. Hartley, yields three-tenths of a cubic foot, and a good oil moderator lamp, according to Hartley, a little more than half a cubic foot in the same time. Roughly, then, taking carbonic acid gas as the sole cause of foulness in the air, we may say that one lamp or two candles are equivalent to one person in a room.

Each cubic foot of gas, according to Mr. Hartley, yields from .51 to .63 of a cubic foot of carbonic acid gas, so that a common burner, consuming three cubic feet of gas, is nearly equivalent to three additional people in the room. Speaking roughly, from the evidence of one's senses, this statement is not

improbable; the usual three lights, burning properly, represent, therefore, nine or ten additional people in a small room. Mr. Hartley also says that a duplex lamp, by Hinks of Birmingham, burning 50 grammes of paraffine per hour, gave off 3.3 cubic feet of carbonic acid gas, or as much as six or seven people. This manner of comparing different lights is extremely rough, for each source of light, besides carbonic acid, gives off other foul or offensive vapors. We may, however, feel very sure that it does gas no injustice, for gas is seldom burned under very favorable conditions. If the burner is a little out of order, or if the pressure does not exactly suit it, we have carbonic oxide formed instead of carbonic acid, and this is a much more objectionable compound. Moreover, there come, even from the best gas, a number of by-products, more or less offensive. These facts show us that our senses are entitled to attention when they inform us that a room lighted by gas is usually intolerably close. Moreover, we, living at the bottom of a room, only experience the effect of the colder part of the air in the room. If the reader will go up a flight of steps to the top of a room in which many gas-lights have been burning for a few hours, he will not require any sci-

entific evidence to convince him that the gas has produced a very considerable and objectionable modification in the air. He may then remember that, although this air will not reach his lungs until it has cooled and fallen down to his ordinary level, nevertheless, if fresh air have not been admitted, this old air will be just as foul when cool as it was when hot, and although less immediately offensive, it will be hardly less unwholesome. The foul air produced by gas contains no taint of disease, and therefore does not directly kill; it simply lowers our system, produces headache, lethargy, and poor health.

The best mode of dealing with the products of combustion from gas undoubtedly is to lead them at once into the open air by a separate chimney, so that they never mingle with the air we breathe; but this perfect arrangement is seldom practicable, and is always expensive. The central gasalier of a room may, indeed, always be so treated, the chimney for it being taken between the ceiling and the floor of the room above to the outside wall. They are handsome, in the ordinary ironmongery sense. The æsthetic eye loathes them—but, indeed, they are hardly worse than most ordinary gasaliers. They

should certainly be used in every public or club room.

This perfect remedy has long been before the public, but has made comparatively little way except in public institutions. It is far too expensive for lodgings or cheap houses, and is, moreover, wholly inapplicable to the gas-lights which are placed on single brackets round the wall.

These bracket lamps are much too convenient to be abandoned, and we must therefore seek some other remedy.

The simplest and best remedy is not to burn more gas than is really required; not to light three burners when one will do; not to leave the gas burning for hours in an unoccupied room. Luckily for our lungs, the glare of gas-light is becoming unfashionable, and we no longer try to make our drawing-rooms look like gin-palaces by lighting twenty or thirty gas jets. This cheap form of ostentation is out of favor, and one is tempted to be very grateful to the inventors of the Queen Anne style, not only because it is pretty and quaint, but because it allows one to open one's eyes, and to have air fit to breathe. If gas is burned in moderation, the simple inlets and outlets described above will keep our rooms in a very habitable state.

A word is desirable as to the practice of turning gas down so as to leave a bead burning. This is a condition favorable to the production of the objectionable gas, carbonic oxide. Where possible, therefore, the gas should be turned quite out.

In conclusion, if you are so hardy, or have tastes so vitiated that you are yourself indifferent to foul air, do not be forgetful of your weaker brethren, as you think them. Do not think it a duty to teach them that they ought rather to enjoy filth in their lungs. Indeed, you ought not to look on their gasping as a sign of effeminacy, but rather to remember that it is the Highlander who, fresh from his hills and draughty shieling, faints in the crowded room; that it is the healthy Englishman abroad who insists on having the railway carriage window down, and cannot endure ten smoking, steaming persons in one close compartment; that it is the shivering, under-fed, overworked, unhealthy clerk or factory-girl who cannot endure fresh air, and believe that if you do not feel the room close when others say it is, this is no strength in you, but a sign that you are unhealthy or ill-clothed.

This word of warning is especially addressed to school-masters and clergymen; they

are often sedentary men, trained by long practice to low health and bad air; they are busy and excited in their class and pulpit, and they too often neglect the health of their class and congregation because they themselves suppose that they do not suffer, or they make a whole class or congregation suffer because for themselves they dread a little cold air. Selfishness in both cases. The writer knows of one church which is heated, but not ventilated, in the very cheapest way conceivable; the air is drawn out of the church into a chamber where there is a cast-iron stove. It is there heated and then returned to the church, to be again withdrawn, and so on in a cycle for ever and ever.

NOTE.—The whole of this section is applicable to American conditions, save that it is obvious that the warming of houses by "furnaces" is much less common in Scotland than here. A very large proportion of our houses, of the class in which Mr. Jenkin's recommendations are likely to find favor, are so warmed, and the warm-air flues—supplied with air from without—furnish adequate fresh-air inlets, so that we have chiefly to consider proper means of exit, the best of all being an open chimney. The statements made in this lecture indicate clearly that warm-air registers should be in the floor, so as to send their current upward, rather than in the side wall.—*Am. ed.*

PART II.—WATER-SUPPLY.

THE water supplied to Edinburgh is of good quality, and the only problem we have at present to consider is how to store it for use so that when in our houses it may not be contaminated. A constant supply is certainly desirable, in place of the intermittent supply which we now receive, and would remove many of the dangers now to be spoken of; but on this occasion I shall restrict myself to the consideration of what each householder can himself do, without entering on the much more general subject of the best manner of supplying a town.

Since the pipes which supply our houses are not kept full day and night, whereas we do or may require to draw off water at any moment day or night, we are obliged to provide cisterns in which to store the water; these cisterns are filled during the time that water is turned into the main pipes which supply our particular street, and they must be of sufficient size to contain all the water we may require for a couple of days, so that if by accident a main pipe is under repair

for a day, we need not become aware of the fact, since our private store will be sufficient for our wants. It follows, however, that much of the water we use remains for some hours in the cistern, where it forms a stagnant pond; indeed, if we leave our house for a time, on our return we shall begin by using water which has all that time stood stagnant in the cistern, unless we take the precaution of running it off. We must, therefore, take care that the cistern be not so made, or placed, or arranged that water standing in it shall be liable to contamination. We receive pure water; we must keep it pure. What is the common practice? Our cisterns are habitually made of lead; they are usually placed in water-closets. They frequently are so arranged that sewer-gas or foul air from the closet must from time to time bubble through the water, or in other cases pass continually over its surface.

Lead-poisoning is a term which must be familiar to all, and this occurs when the water in a lead pipe or cistern dissolves the lead, so that it is drunk by the family daily in very minute quantities. There is usually nothing in the appearance or taste of the water to give warning of the poison. The

conditions under which this lead is thus dissolved are somewhat obscure, and fortunately our Edinburgh water seldom acts in this manner on lead. Most writers on hygiene recommend the use of slate cisterns, or galvanized iron cisterns, or stone-ware cisterns, so as wholly to avoid the danger. The public, however, partly guided by tradesmen, continue to prefer lead, looking on the risk of poisoning as infinitesimal, whereas the risk of leakage from the other forms of cistern is serious, requiring what is called a safe underneath them to carry away the dripping water. I am not prepared to advise that in Edinburgh lead cisterns must be given up, but it is certain that where they are used the medical man must have the possibility of lead-poisoning continually present to his mind. Lead pipes tinned inside have sometimes been recommended, but I cannot advise their use. A very small flaw exposes the lead, and then the water is certain to carry away with it a considerable amount of lead in solution, the action being rendered inevitable by the galvanic current due to the presence of these two metals side by side in the water. Where lead is used, no other material should be allowed to be in contact at once with the lead and the water;

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even putrid organic matter is not in poisonous when eaten, or some deli such as a woodcock's trail or Stilton c would be fatal; for years we may con to drink diluted sewage, and be only a the worse, but let the poison-germ of specific disease once be communicated t sewage by which the water is polluted at that very hour the water which was n ly nasty becomes poisonous. From a tary point of view we shun organic m in water, because that organic matte usually in part derived from sewage, an shun sewage in the water because all sev is liable to be tainted—that is to say, t charged with poison-germs which have c from the bodies of diseased persons. Le one therefore suppose that because water been drunk for years from a given cist over a water-closet, with impunity, th can be nothing wrong with that cistern. order that this experimental test should h any value, it must be shown that while water was being drunk infectious epidem had prevailed in the neighborhood, and e that the closet itself had served as a pass for tainted matter.

The most positive evidence exists th diseases such as typhoid fever are contra

even mortar seems to produce the corrosion of lead when lying on it under water.

If too much is sometimes made of the danger attending the use of lead, too much cannot be said of the danger of placing and arranging cisterns so that the water may be contaminated by sewer-gas or tainted air. Water absorbs gas as a sponge absorbs water, and will assuredly imbibe a sensible portion of every tainted breath which blows upon its surface; much more will it become highly charged with poison when tainted air is actually blown through it. Foul air is bad enough when breathed, but its effects are more deadly when the taints it contains are taken into the system with the water we drink; therefore, it is a first duty to see that the cisterns from which we draw our drinking-water are so arranged, that under no circumstances can any taint of disease pass from the sewer or water-closet into the water. Nevertheless, we continually draw our water supply from a store standing in places where the air is either always or at times offensive to the smell. If it be asked, How then do we enjoy such good health on the whole? the answer is, Because nastiness is not poisonous; organic matter in the water is not in itself poisonous, or soup would be deadly;

even putrid organic matter is not in itself poisonous when eaten, or some delicacies, such as a woodcock's trail or Stilton cheese would be fatal; for years we may continue to drink diluted sewage, and be only a little the worse, but let the poison-germ of some specific disease once be communicated to the sewage by which the water is polluted, and at that very hour the water which was merely nasty becomes poisonous. From a sanitary point of view we shun organic matter in water, because that organic matter is usually in part derived from sewage, and we shun sewage in the water because all sewage is liable to be tainted—that is to say, to be charged with poison-germs which have come from the bodies of diseased persons. Let no one therefore suppose that because water has been drunk for years from a given cistern, over a water-closet, with impunity, there can be nothing wrong with that cistern. In order that this experimental test should have any value, it must be shown that while the water was being drunk infectious epidemics had prevailed in the neighborhood, and even that the closet itself had served as a passage for tainted matter.

The most positive evidence exists that diseases such as typhoid fever are contract-

ed by drinking water over which tainted smells have passed, or through which tainted gas has been blown; and, moreover, the quantity of gas or foul-smelling air required to taint the water is extremely small *when real poison-germs are present.*

We must, then, place all cisterns from which pure water is to be drawn in pure air—that is to say, in halls, or passages, or airy rooms; we must not place them in water-closets or in bedrooms. In this simple way we avoid all danger that the water should absorb taints by its exposed surface. Any one may see how readily water absorbs matter from the air by placing a pail of water in a room where there is a smell of paint; in a few hours it is covered by an oily scum drawn from the air.

Where the cisterns placed over a water-closet are unavoidably used, as may be the case when we occupy lodgings for a short time, let us at least take care that the closet is well ventilated, and above all, that the following dangers are avoided: The pipe which brings the water down to the closet must never stand empty. If it does, foul air from the closet will certainly accumulate in it, and when water is admitted to the closet this air will bubble up through

the cistern. It is not necessary to be a plumber or an engineer to see whether this happens or not. Let the householder look into the cistern while the handle of the closet is pulled up at short intervals. If he sees bubbles of air come up through the cistern on any occasion when this is done, he may know that these bubbles can only have come up the pipe from the pan of the closet, and he may feel sure that these bubbles will often be charged with offensive matter, and sometimes with poison. The defective arrangement producing these bubbles is called a wire closet; the valve admitting water to the pipes is placed at the top of a pipe, which is therefore filled with air drawn from the pan of the closet after each discharge, and, when the valve is opened, as water rushes down so the air escapes up. The remedy is to place the valve close to the pan, so that the pipe to the cistern always remains full of water. This matter is well understood by the leading plumbers.

A half-and-half protection is obtained by dividing the cistern above a closet into two parts, one for the closet and one for drinking purposes. This does lessen the risks, and is better than nothing. A much better plan is to add a small separate cistern for

the water-closet, drawing its supply from the main cistern by a ball-cock.

Wherever a cistern may be placed, the overflow-pipe from it must on no account run into any pipe which receives foul matters; it should never run into what has been called in the first lecture the red system, nor yet, if this can be avoided, into the yellow system. A separate overflow for pure water should be provided. This point is also well understood by the leading plumbers. It has been insisted upon in many Government reports, and is, indeed, most vital. Probably more cases of poisoning have been tracked home to the practice of connecting the overflow-pipe of a cistern with the soil-pipe, than to any other defective fitting in a house. The arrangement is forbidden by law in new houses. It is often a troublesome matter in an old house to ascertain where these overflow-pipes do go, but it is well worth while to incur expense in tracking them to their outfall.

It must be borne in mind that, where a cistern is not to be used for drinking purposes, no tap must be allowed in connection with it, so placed that water can possibly be drawn off; otherwise, from time to time, water will be so drawn off and drunk. Wa-

ter used for baths should, in my opinion, be as pure as that used for dietetic purposes.

The overflow-pipes from kitchen boilers should be as free from suspicion as those from the cisterns for drinking-water.

A remarkable case of disease, caused by drinking tainted water, occurred at Caius College, Cambridge, where fifteen persons out of sixty-three using the water were attacked by enteric fever. The water in this case was tainted by air drawn into the pipes from one water-closet. The arrangement in this instance was different from that described as a wire closet. The water-closet in question was supplied direct from the main, without the intervention of any cistern. Although the supply was nominally constant, the pipes were occasionally empty of water, and the air which then entered was in part drawn from this closet. This air was sufficient to contaminate the whole water-supply of the house. The arrangement by which a water-closet takes its supply direct from the mains, without an intervening cistern, having an exposed service, should never be sanctioned. It may be described as a direct connection between the red and black systems of the diagram. There are other horrors occasionally discovered, on

which it is impossible to dwell. Sometimes the cistern supplying drinking-water continually receives driblets or spurts of the foul matters going down the red system; sometimes each water-closet allows some portion of its contents to trickle down into a cistern on the floor beneath, and this cistern is used for a second water-closet, and also to supply drinking-water. These horrible defects are not discovered until some inmate of the house contracts infectious illness, which then spreads with frightful virulence among the inmates. An inquiry is then instituted, but only after the mischief has been done. The systematic inspection of the Sanitary Protection Association will protect all houses under their inspection from horrors like these. Charity could hardly be better directed than in putting the poorer classes of tenements, where these things most frequently occur, under inspection.

When water is delivered into a house pure, and when it is so stored as to remain pure, domestic filtration is obviously unnecessary. In many parts of London and other towns the above conditions cannot be realized, but in Edinburgh, if we place and fit up our cisterns properly, we need use no fil-

ters. If we do filter the water, with the idea of making assurance doubly sure, we must be careful not to spoil the water by the very process adopted to improve it. Some persons appear to regard filters as having some inexhaustible cleansing property—a property which, if they possessed it, would be as wonderful as that of Aladdin's ring. In truth, a given weight of purifying material, such as animal charcoal, will purify a certain definite quantity of a given water, and no more. If more water is passed through the charcoal, the charcoal begins to dirty the water instead of purifying it. In almost all cases filters are kept in use long after their virtue has passed away. It would be well if they were at least harmless, like the talisman which may be seen round the neck of every Italian peasant, but this is not quite so. The filter becomes a breeding-place for worms and disgusting organisms, which abound in the water passed through it. These worms and organisms are fortunately not very dangerous to us, because a filter is seldom placed where the taint of any given infectious disease is likely to reach it; but still it is not pleasant to drink dirty water when we might drink it clean, and we can see that a filter in this foul state

can never act so as to remove a taint of disease, if this has been communicated to the water before it reached the foul filter. Most persons think that a filter continues efficient so long as water will pass through it, and they are confirmed in this idea by the advertisements describing filters.

The idea is not unnatural; for filtration seems at first sight to be a mere mechanical detention of particles of dirt, such as we obtain when passing fluids through a strainer of muslin or blotting-paper. We are all familiar with this action, and many people do not hesitate to give a certificate that a filter remains as perfect in its action now as it was twelve years ago, when they really do not know that the water is being purified by the filter at all, and merely know that water continues to flow through at much the same rate as it used to do.

The mechanical separation of dirt from water is in fact only a small part of the duty of a filter, and would not in all probability remove any very considerable part of the disease-germs or taints in the water. There is another curious action, of a chemical nature, by which matter in solution, as well as matter in suspension, is either removed, or so modified as to be harmless. Chemists

have of late years considerably modified their views as to the nature of this action, and I am not certain that even now the final judgment has been passed as to the action of such a substance as animal charcoal. On one point, however, all chemists are agreed. A given weight of purifying material possesses only a limited power of purifying. The purification may, as is usually supposed in animal charcoal, be due to an oxidation of the organic matter, or, as in the case of spongy iron, a deoxidation of the same matter; but neither oxidation nor deoxidation can be produced, except to a definite extent, by a definite quantity of filtering material. When this filtering material has been used up it must be changed, if the filter is to remain really efficient.

The advertisements of filters are, as a rule, extremely misleading. For instance, a filter will be described as "self-cleansing." This is a term which would lead any one to suppose that the filter might be used forever with no renewal of the filtering material. The term usually seems to mean this—that from time to time, by reversing the direction of the water through the filter, the user may wash away a part of the mechanical impurities which are strained out of the water

by the first layers of filtering material, and which are kept back in a kind of dirt-pond. This may or may not be a good arrangement. I think it bad, and prefer not to pass clean water from a cistern through this dirt-pond; but, even if it were a good arrangement, it does not dispense us from the duty of wholly changing, from time to time, the filtering material which performs the duty of acting chemically on the organic matters in the water, whereas the term "self-cleansing" would lead us to suppose exactly the contrary. The same remark applies to those forms of filter which are described as having the filtering materials so arranged that the surface can easily be cleansed by a brush, or by scraping from time to time. This cleaning does not renew the interior of the material, and merely removes the mechanical impurities with which the outer layers are clogged. The process rather tends to induce the householder to go on using the material longer than he otherwise would, which is a harm, not a benefit. Then many filters, perhaps most filters, have the filtering material carefully built in, so that the householder cannot change the filtering material, and is not expected to do so. If he wants new filtering material he must buy a new filter.

A filter of this class should bear stamped on it some inscription, such as the following: "Good for 12,000 gallons of Thames water," or "Good for six months' domestic consumption of a family of nine persons—Thames water." Then there should be a card where the user could note when he began to use the filter, so that he might see when it would be worn out. Suggestions of this kind seem quite Utopian, and yet, unless they are carried out, domestic filtration will remain what it is—a mere farce.

The following quotation from the Sixth Report of the River Pollution Commissioners will show that the language here used is not at all exaggerated:

"Filtration on a small scale may, if carefully performed, be rendered much more efficient than the water-works process, as at present most frequently conducted; but we are bound to say that domestic filtration, when left to the care of average servants, not only entirely fails to purify the water, but actually often renders it more impure than before. No other result can be expected if we consider the work the domestic filter is called upon to do. A small volume of filtering material is crammed into the smallest possible space, and then for months, or even years, water, more or less polluted, is passed through it, till the pores become so clogged with filth as to refuse the

transmission of more liquid. Long before this happens, however, the accumulation of putrescent organic matter upon and within the filtering material furnishes a favorable nest for the development of minute worms and other disgusting organisms, which not unfrequently pervade the filtered water, while the proportion of organic matter in the effluent water is often considerably greater than that present before filtration.

"It cannot be too widely known that, as a rule, domestic filters constructed with sand, or sand and wood charcoal, are nearly useless after the lapse of four months, and positively deleterious after the lapse of a year. In such filters the material ought to be renewed every four months, if the filter be much used.

"Of all materials for domestic filtration with which we have experimented, we find animal charcoal and spongy iron to be the most effective in the removal of organic matter from the water. We are not prepared to say that these are the only materials in actual use that are efficient; they are, however, the only successful ones among those of which we have had the opportunity of making satisfactory trials."

Analyses of various filtered waters are then given, and the Report proceeds:

"The removal of mineral constituents, and the consequent softening of the water, ceases in about a fortnight, but the withdrawal of organic matter still continues, though to a greatly diminished

extent, when the filter is much used, even after the lapse of six months.

"It is necessary, therefore, to renew the animal charcoal in these filters after a lapse of not more than six months, when they are used for the cleansing of the New River Company's water, and when the whole household water is filtered through them; but if the drinking-water only be filtered, a much less frequent renewal is required. Thames water, as supplied by five of the eight London Water Companies, is more than twice as polluted as that delivered by the New River Company, and it will therefore be necessary to renew the animal charcoal used in the filtration of such water at least twice as frequently.

"Indeed, we found that myriads of minute worms were developed in the animal charcoal, and passed out with the water when the filters were used for Thames water, and when the charcoal was not renewed at sufficiently short intervals. The property which animal charcoal possesses in a high degree, of favoring the growth of the low forms of organic life, is a serious drawback to its use as a filtering medium for potable waters.

"We have obtained still more remarkable results by the continuous filtration of water through metallic iron which had been prepared by the reduction of hæmatite ore, at the lowest practicable temperature, by carbonaceous matter. The iron thus obtained, not having been melted, as in the ordinary smelting furnace, is in a finely divided

and spongy condition, and appears to be a very active agent, not only removing organic matter from water but also in materially reducing its hardness, and otherwise altering its character when the water is filtered through the spongy material."

Bischoff's Spongy Iron Filter is at present very highly spoken of; and in his advertisements we do find a warning that the filtering material should from time to time be renewed. It is not a little amusing to find this suggestion most prominently made in the case of the filtering material which was found by the Commissioners and Dr. Frankland to remain efficient for the *longest* time. Rawlings's Excel Filter is an animal charcoal filter in which provision for renewal is made. Danchell's Filter is also described as so made that the filtering material can be renewed, and, doubtless, other advertisements contain similar words. None of the advertisers venture, however, to insist properly on the absolute necessity of renewal.

Filters are of some use in removing lead from water in which it has been accidentally dissolved.

Before leaving the subject of water, a word may be desirable as to country houses. The occupier of a country house should always

submit the water-supply to the judgment of a competent analyst. Our senses may be trusted when they tell us that water is nasty. Their evidence is worthless when they pronounce it pleasant. Delicious water may be very deleterious. In country houses the builders have an awkward habit of placing cesspools or leaking drains close to the well from which the water-supply is drawn. This arrangement may go on for years and produce no disease, but let the taint be once introduced from without, and the disease must pass through the household, and perhaps linger for years, breaking out from time to time, as circumstances favor the development of the germs. Coloring matter, if it comes from a peaty soil, is of small consequence, but is otherwise a sign that the water should be examined by a chemist. The color of water is best seen by looking down at white paper through a vessel of water some feet in height. Color may then be observed which would in other circumstances escape notice. The hardness of water has not been proved to be unhealthy. It is simply inconvenient, causing greater expense for soup and tea, and rendering palatable cooking more difficult. Water may be softened by processes which are

neither costly nor very troublesome in their application.

NOTE.—The caution given in the case of an intermittent supply applies as forcibly, though less constantly, where the supply is continuous. In New York, for example, it is a freqnent experience, on opening a faucet on an upper floor when water is being drawn below, to hear air rushing into the pipe. If it is the valve of a water-closet which is opened, the air of the closet-bowl is drawn into the pipe, and the purity of the water is endangered.—*Am. ed.*

Lecture III.

SANITARY INSPECTION.

THE writer asked permission to lay before the Medico-Chirurgical Society the first account of the manner in which it is proposed that the inspection given by the Sanitary Protection Association shall be carried out, because it seemed to him that the medical profession more than any other was interested in the establishment and working of this Association. In respect of domestic sanitation, the business of the engineer and that of the medical man overlap; for while it is the duty of the engineer to learn from the doctor what conditions are necessary to secure health, the engineer may, nevertheless, claim in his turn the privilege of assisting in the warfare against disease, by using his professional skill to determine what mechanical and constructive arrangements are best adapted to secure these conditions.

The writer will, therefore, explain what, in his view as an engineer, are the chief ob-

jects of inspection in an ordinary Edinburgh house. In doing so, he must not be understood as exhaustively treating every condition which is known to be desirable, but rather as restricting himself to those vital and practical conditions which can be secured with little expense and no inconvenience.

1st. It is clearly necessary that each house should be drained, or, more properly speaking, sewered—that is to say, all fæcal and other refuse matters, in a liquid form, must be conveyed rapidly to a distance from the house; usually they should be taken to the common sewer, but a properly-constructed cesspool is admissible as a receptacle for the liquid filth of a house. [It may be noted that the plumbers of Edinburgh often use the word cesspool to mean that which, in other parts of the country, and in sanitary writings generally, is called a trap.]* A very considerable percentage of houses in all large towns are so imperfectly sewered, that while the occupiers believe that filth is being conveyed to the common sewer, in fact it is being deposited by continual leak-

* And most of our water seal-traps *are* cesspools.—*Am. ed.*

age in the basement of the houses. The author has in the last few weeks heard of at least a dozen cases of this kind, each followed by disease or low health in the house. The absence of sewerage is due both to defective joint construction, as where ignorant laborers lay pipes sloping the wrong way, or fail to complete the connection between the iron sewer and the house drain, and to subsequent injury, as where the house drain is stopped up by an accumulation of rubbish, or broken by unequal settlements.

It is found that, in order to secure the first and paramount condition of health, it is not only necessary that the drains should be properly constructed in the first instance, but that they should be systematically inspected from time to time. Cases are very numerous in which complete stoppage has lasted for years without being suspected by the inmates of the house, although this condition has almost invariably been followed by illness in the house.

2d. It is very desirable that each house should, as to sewer-gas, be thoroughly isolated from its neighbors. This principle of isolation is no less important than that of the rapid removal of the home-made filth. It can be secured by the combination of one

or more barriers to the upward passage of germ-bearing air from the common sewer into the house sewer, with an open channel affording what may be termed a safety-valve, so placed that even if the tainted air be forced past a barrier, such as that which a common water-trap provides, nevertheless this tainted air shall not enter the house system, but shall be diverted to a place outside the house where its discharge may be innocuous. Potts's (Fig. 2), Mansergh's, and Hellyer's traps all aim at carrying out this idea, the full advantage of which, however, can be secured by having a short length of the house sewer open to the air through a grid in an area or coal-cellar,* this open length being guarded by ordinary water-traps on either side, so that the area exposed to the open air does not exceed that in the ordinary house-maid's pail. The thorough and absolute exclusion of every germ present in the lower sewer from each house sewer is the object here to be aimed at. No system which merely diminishes the number of germs admitted into the house sewer can be regarded as satisfactory. It is nec-

* Where the coal-cellar is not the house-cellar, nor in communication with it.—*Am. ed.*

essary, from time to time, to see that these traps are not clogged, and that, above all, the ventilating opening has not been obstructed through carelessness or ignorance.

3d. It is necessary that the whole system of piping inside a house should be water-tight and gas-tight. There may be a free passage for sewage out to the common drain, and complete isolation from sewer-gas, and nevertheless filth, and possibly tainted filth, arising inside a house, may leak out into the basement through defective joints or cracks in a pipe, or in the form of gas into the dwelling-rooms. To prevent this, we must make sure that the piping is sound, and that wherever an inlet occurs for liquids the exit of gases shall be effectually prevented by properly constructed water-traps. Here, again, originally sound design and construction will not permanently secure the object aimed at. Pipes corrode and break, joints give way with time; moreover, when alterations are made, defective work is not unfrequently introduced. Hence periodical inspection is absolutely necessary to safety.*

* *All* house drains, within the foundation walls, should be of cast-iron pipes with lead-caulked joints,

4th. It is desirable that the inside of the pipes used to convey foul matters should be thoroughly ventilated or aerated, inasmuch as the presence of large volumes of air tends to prevent that kind of decay which produces noxious gases, and, even when these are generated, tends to neutralize their noxious character. It is not only desirable that we should, by sound pipes and good traps, exclude from the house all danger which may arise inside those pipes, but also that we should, so far as is possible, prevent the dangerous elements from ever coming into existence. Engineers are in less perfect agreement as to the best mode of ventilating house drains than as to the points hitherto mentioned. To the writer it seems probable that there are many ways in which this object can be effected without great difficulty or expense, and certainly without the use of any patented apparatus. It appears to him as if sanitary reformers, by striving for too much, were defeating their own ends, and preventing the public from adopting any ventilation whatever. He is disposed to think that great laxity may be safely

and, where possible, they should *not* be under the cellar floor.—*Am. ed.*

permitted in respect of the ventilation of the house drain, provided the cardinal condition is observed that every section between two traps is allowed in some way to communicate with the outer air. Ventilating openings are necessarily subject to be choked with dirt or closed by carelessness; and inasmuch as those stoppages lead to no immediate or apparent inconvenience, this stoppage is almost certain to escape detection, unless some inspector methodically examines the passages intended to act as ventilators.*

5th. The water used for dietetic purposes must be preserved clean. To do this, the cistern must be of suitable materials, and placed where no foul air can pass through or over the water. Drinking-water should never be drawn from a cistern used to supply a water-closet, or placed in a water-closet; but to enforce this rule would entail so much inconvenience and expense, that, in old houses, the engineer may sometimes permit the practice, provided the two special dangers are avoided to which these cisterns are liable. These dangers arise (1) from

* It is a great safeguard in these matters to have the ventilating pipes of large size—for soil-pipes, not less than four inches in diameter.—*Am. ed.*

overflow-pipes directly connected with the soil-pipe; and (2) from badly-designed pipes and valves supplying the water-closet.—These pipes and valves are sometimes so ill-contrived that, whenever the closet-handle is pulled up, a rush of foul air occurs from the pan of the closet through the water of the cistern. When these two gross defects are avoided, the danger of drinking water from the cistern placed over a water-closet is much diminished; nevertheless, in the writer's opinion, in all new houses builders should be compelled to provide separate cisterns for the water required for dietetic purposes; and wherever the owner of an existing house can afford to make the change, it certainly should be made. Inspection of cisterns is very desirable from time to time, in order that any corrosion of lead or accumulation of dirt may be detected. It is also desirable as a means of detecting and checking alterations, which are not unfrequently made by ignorant or careless plumbers, with the effect of spoiling arrangements which were originally good.

In the above summary of the objects to be aimed at in designing the sewerage and water-supply of a house, the writer has endeavored to advance nothing which would

not meet with the support of the great majority of the ènginеering profession; he has avoided all controversies as to the relative merits of the dry system and the water-carriage system, or as to the relative merits of various means of carrying out either of these systems.

These questions are far too large to be discussed in a single paper; and, moreover, the question which most frequently comes before the medical man is, how to insure that some existing house or an existing town may be made and kept healthy.

The writer thinks that, by attention to the five cardinal conditions enumerated above, this healthiness may be insured without any great expense, and without the use of any patented apparatus. No doubt there are an immense number of details in the choice of materials, of fittings, and of modes of designing and executing work, all of which are important to some extent; but we are so far from any ideal perfection, that sanitary reformers often ruin their own cause by insisting on an impossible perfection in every detail, and by mixing up questions of first-rate and of fifth-rate importance.

When, however, the attempt is made to

apply these simple principles to any one house, the need of technical or professional advice is at once felt, and hitherto the public have been very much in the hands of plumbers and builders, for architects or engineers are rarely called in, except in the case of mansions of very great importance. The medical man has often to suggest changes in the sewerage of a house as desirable, and he is often qualified very materially to assist the householder in determining what changes require to be made; at the same time his recommendations are always liable to be thwarted, not only by the apathy of his clients, but by the ignorance or carelessness of the tradesmen employed to design and make the alterations. Moreover, it is hardly to be expected that the medical man shall always be fully qualified either to design or test sanitary appliances. If he is able to do this, he does it from pure benevolence, receiving no fee, and often small thanks. Moreover, he must often feel that a responsibility is thrown on his shoulders which he is really not called upon to bear, and which he only assumes because no duly qualified person is to be found who will design and examine these sanitary appliances.

When considering these difficulties, the writer was led to the conception of an Association which might not only enable its members to obtain the advice and inspection which they require cheaply, but might also induce them to accept advice and inspection which they might otherwise never think of seeking. He saw that it would be possible for an engineer of the highest standing to give advice to a large and important body, whereas it has not been the practice for leading engineers to advise individuals about their house arrangements, except where large outlay was in contemplation. This point in itself is of very considerable importance. Just as the leading physician of the day may give his services to great numbers of poor patients when these are gathered in a hospital, although he could not practically visit them in their own houses, so the simple fact of the collection of a number of clients into a group will enable the leading engineer to give them the benefit of his advice. The application of the general principles might be intrusted to younger members of the profession, working under the immediate eye of their chief. On this hint the Sanitary Inspection Asso-

ciation has been formed.* Membership is made to depend simply on the payment of one guinea annually. Out of the funds thus provided a leading engineer will be paid as consulting engineer to the Association. The consulting engineer occupies much the same position as the consulting physician. The writer intends to apply for the position, and as he will make no difficulty as to terms, he expects to obtain the appointment. The greater part of the guinea of each member will, however, go to the payment of the executive staff, which will consist of young engineers, each followed by his workmen, who will give their whole services to the Association.

How the objects named above will be promoted by the action of the Association may best be understood by a slight sketch of the manner in which it is proposed that the work of inspection should be carried out. Each member will, in the course of the year, receive a letter from the secretary, asking whether it will be convenient for him to receive the inspecting engineer on a given day. If the member should not

* In May, 1878, the Association had about 500 members.—*Am. ed.*

wish to have his house inspected he will make this known, otherwise he will appoint a day for the preliminary inspection. During this first inspection the engineer will make a diagram of the pipes throughout the house, and will make every investigation which can be made without entailing any expense to the member. He will then draw up a preliminary report, stating whether a complete inspection can be made without expense to the member, and if not, at what cost the necessary alterations in the fittings can in this particular instance be made. It is not anticipated that in any case the expense of preparing for a complete inspection can be great, but in most cases some trifling expense would have to be incurred. If the member states that he does not wish to incur any expense, he will receive the preliminary report, which will give him all the information concerning the sanitary arrangement of his house which can be procured by the inspection of the engineer, aided by one workman. If, however, he is disposed to allow of a complete inspection, the necessary apparatus will be fixed. This apparatus will usually consist of a trap of the type above described, with a ventilating grid placed so as not only to

give the requisite ventilation, but also so as to allow of the following thorough series of experiments, which will be tried on the occasion of the second visit of the engineer: 1. Is the house drained? This will be tested by simply fastening up the water-closet handles for a few minutes, and watching the flow past the grid at the external trap. It is clear that no obstruction can exist on either side of the trap if this flow is seen to be unimpeded. 2. Is there any leakage from the sewer under the house into the basement? if so, of what magnitude? This will be tested by temporarily plugging up the drain at the trap, and filling the pipe or drain in the basement with water. If the water remains at a constant level, the drain is clearly water-tight; if not, the amount of the leakage can be measured by the rate at which the surface falls. No head of water should be put on the drain or pipe, which is usually not designed to resist pressure, but all sewerage pipes passing under the basement of a house should be as tight as a bottle. In old pipes, which cannot be subjected to so stringent a test, the quantity of water poured in at one end may be compared with that coming out at the other. It will, in one of these two ways, be quite

easy to test the soundness of a drain without uncovering it, and to repeat this experiment as often as may be desired. This experiment will also make sure that no old open ends are left connected with the main drain, as not unfrequently happens, with the result of allowing a part of the sewage to run out into the basement. 3. Are the pipes of a house air-tight, and are all openings trapped? This will be ascertained by making fumes of paraffine* inside a closed vessel over the open grid at the trap, and driving these fumes into the house system by a fan, but not so as to cause any internal pressure. When it has been ascertained that these fumes have reached the highest point in the pipes, each room in the house will be inspected, and any escape of paraffine into any room will certainly be smelled, the place of the escape will also be easily detected. 4. Are the traps and pipes of a house properly ventilated? This will be ascertained by endeavoring to put the pipes under a slight pressure by pumping air into the pipes at the bottom. If no paraffine fumes are then forced into the house, it is clear that at least one part of the ventilat-

* Kerosene.—*Am. ed.*

ing system is in order. In addition to this experiment the test of passing smoke through ventilating openings will be made wherever this may seem desirable. 5. Is the drinking-water unpolluted? The cisterns will be examined, the position of the overflow-pipes recorded, and the action of the water-closets inspected (these experiments will, however, usually form part of the preliminary inspection).

Shortly after these experiments have been completed the householder will receive a report stating the result; stating also whether any alteration in the house-fittings seems desirable or necessary, and approximately at what cost these alterations can be made. If they are carried out, the work done will be inspected. All reports will be made according to principles laid down by the consulting engineer, and all doubtful cases will be submitted to him. It will be the object of the engineers to meet the convenience of the members in every way. They will have no interest in advising that work should be executed, or any particular apparatus adopted. Moreover, their reports will be made subject to the check which an elected council will afford.

It is expected that the result of these first

complete examinations and reports will be to cause the house to be put in thoroughly good order, as regards sanitary arrangements; but it may have been observed that not one of the five conditions laid down as essential can be permanently secured without systematic inspection. It is too often supposed that all that is necessary in a house is once for all to put the drains in good order, and that ever afterward they may be wholly forgotten. Dr. A. Fergus, of Glasgow, would be able to give some striking illustrations of the fallacy of this supposition, and every medical officer of health must know how completely false the assumption is. The fact that a drain is free to-day, gives no guarantee that it will not be choked up five years hence. The fact that it is water-tight to-day, gives no guarantee that, whether by the perishable nature of the materials with which it is made and jointed, or by such accidental causes as unequal settlement or occasional violence, the drain may not be seriously leaky five years hence. The fact that pipes to-day are air-tight, gives no guarantee that lead will not corrode or iron rust, so as to let out sewer-gases hereafter. Cisterns may be well placed and well fitted up, and yet be

so neglected that they become foul; and the fittings may become so rusty and corroded as to act improperly and injuriously. Lastly, alterations may be made heedlessly or ignorantly, which may actually withdraw the protection originally afforded. In the writer's opinion, house-fittings, even when constructed according to the best possible system, should be periodically inspected, and this inspection will be given yearly by the Association, under the superintendence of highly skilled men.

It should be observed that the Association aims at giving a new thing, or rather a thing which, though not absolutely new, is yet quite new to the ordinary householder. The Association does not aim at doing better something which the architect or the plumber has hitherto done, but at doing something which neither architect nor plumber ever do. Neither does it relieve the municipality from any part of its responsibility. The municipality may intervene inside a house where some evil has already occurred, or where neighbors are injured, but it can never undertake the private duty of keeping internal fittings in good order by periodical inspection. It might as well inspect the beds and bedding

of the inhabitants, to see whether these are sufficient. Each householder must manage his own house-fittings in his own way, but he may make sure of obtaining sound advice and careful experiment by the payment of a guinea to the Association.

It will be seen that the joint inspection will be neither costly nor inconvenient; that the object of the Association will be rather to insure that existing fittings are in sound working order than to suggest the adoption of novel appliances; that there is no pretence or wish to take the work of architects or of plumbers out of their hands. When alterations on a large scale are necessary, the designs for these clearly cannot be made for a guinea; the householder will, in these cases, be advised to consult an architect. Privacy will be secured, for no reports will be made public beyond such general statistics as have a general interest. In fine, the Association will meddle with no existing interest. It will educate the community in sanitary matters, strengthen the hands of the public authorities, and indirectly exercise a most beneficial influence over the work executed on all new buildings. It will foster the introduction of many new minor contrivances, such as ven-

tilators, stoves, and so forth, which often remain unknown to the general public for years after their invention, and at the same time it will offer some check to unscrupulous advertisers.

Lastly, the Association will, it is hoped, be of great use to the poor, who cannot afford themselves to pay the guinea subscription. It is intended that members should have the privilege of obtaining reports on poor houses at small rates. In this way those who visit the poor may learn definitely what is the matter, when they have reason, from the presence of foul smells or otherwise, to suppose that defects exist. The Association will have no power to compel any one to remedy those defects, but may, when the council think that the law is being broken, bring the case to the notice of the proper authorities. In other cases the defect may be remediable at so small a cost, that either the landlord may be induced to make the change, or charity itself may provide what is required. In any case, to know definitely what is wrong, is to advance a long way in the direction of providing a remedy. Systematic investigations of this kind, moreover, will provide a large body of valuable statistics, which may serve to show

in what direction existing laws require modification. It must be borne in mind that the Association will only step in where invited, and where it is welcome. Schools, public and private, hospitals, almshouses, hotels, lodging-houses, should all be inspected; and it may be well to mention that the occupier of a single flat is not excluded from the benefits of the inspection, even though his neighbors may refuse to concur in any joint action. It will be the aim of the engineers to make each occupier independent, as far as may be, of his neighbors.

Two strange fallacies deserve notice. One is, that it is of no use to put private sewers in good order so long as public sewers are in bad condition. This is eminently untrue; for the worse the condition of the public sewer, the more necessary is it that each house should be cut off and protected by the perfection of its internal arrangements. The other fallacy is, that if town sewers were good, there would be no need for good internal fittings. This is certainly absurd; for, independently of the dangers which arise within the house itself, and which may be sufficiently serious, it may be said confidently that the best managed public sewer, receiving, as it does, the taints of

numerous diseases, must always be a source of some danger to all houses into which common sewer-gas is admitted.

It is hoped that the medical profession may give their hearty support to the new movement; that they will do so may be augured from the ready adherence which the Presidents of the College of Physicians and the College of Surgeons gave to the scheme. The responsibility of a medical attendant is heavy enough, as it seems to the author, to make him welcome any proper means by which he may be relieved from the responsibility of giving advice concerning drains and other engineering matters — advice which has certainly, in thousands of cases, been beneficial, but which can neither be given with the fully trained knowledge of the engineer, nor be received as coming with such a clear authority. Moreover, in recommending the Association, the medical man will not exercise any invidious patronage; he will merely tell his patients that a council of men, well known to them, have selected professional advisers who are likely to be thoroughly competent, as having been carefully selected by such men, and who are certain to gain immense experience in the course of their annual inspections.

NOTE.—For our use the "disconnection" traps, such as that shown in Fig. 6, are insufficient, for the reason that their air-grates would often be closed by snow for weeks together.

The use of lead for soil-pipes is absolutely inadmissible; and, so far as practicable, *all* waste-pipes—absolutely all which are not in plain sight—should be of iron. Lead corrodes in the most unsuspected places, and often becomes perforated by the corrosion in such a way as to allow the free escape of drain air. Iron rusts, it is true, but cast-iron is in a way protected by its rust, and is practically as enduring as the house itself. Either cast or wrought iron, protected by the black enamel of the American Enamel Company of Providence, R. I., is practically as indestructible as glass. All wrought-iron pipes should have screw joints, and the joints of cast-iron pipes should be filled with molten lead, securely caulked. Whatever may be the case abroad, it is quite possible here in America so to arrange the sewerage of a house that the need for periodic inspection will be confined to short branch pipes in full view. Here, no less than there, there is not one house in five thousand which is not sorely in need of exactly the inspection—and *improvement*—which the Edinburgh Association purposes to furnish.

Prof. Jenkin gives less prominence to the house-drainage system, as compared with the public sewers, than we think it demands—probably less than he would himself acknowledge to be demanded were the question put squarely to him. "Sewer-gas" is at least as often and as largely a product of the soil-pipe as of the sewer. Prof. Jenkin has followed the custom of most writers on sanitary subjects in accepting the

plumber's water-seal trap as a satisfactory device. He points out its more glaring defects, but he contents himself with describing how those defects are to be met. He accepts the trap as at worst a necessary evil. This is the only really weak point of his work. The water-seal trap, unaided by some suitable mechanical obstruction—and there is more than one of these in successful use here—is always untrustworthy and an object of suspicion, for water stands in the same relation to gases as that in which sponge stands to water. It may stop a current, but it will not prevent a leak.—*Am. ed.*

THE END.

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